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THE MACROECONOMIC IMPACTS OF FEDERAL POLLUTION CONTROL PROGRAMS

CHASE ECONOMETRIC ASSOCIATES, INCORPORATED

PREPARED FOR
COUNCIL ON ENVIRONMENTAL QUALITY

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The Macroeconomic Impacts of Federal Pollution Control Programs

by
Chase Econometric Associates, Inc.
Bala Cynwyd, Pennsylvania

undertaken for

The Council on Environmental Quality
The Environmental Protection Agency

January 1975

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FOREWORD

This analysis of the macroeconomic impact of pollution control expenditures was sponsored by CEQ and EPA as part of a continuing effort to assess the impact of environmental programs on the economy. Further studies on this issue are expected to be released this year.

The analysis is based upon CEQ/EPA estimates of "incremental abatement costs" associated with current Federal air and water pollution control legislation. These costs are defined as the public and private expenditures expected to be made as a result of Federal environmental legislation which would not have been made in the absence of this legislation. The methodology and data sources used in estimating these costs are described in the fifth annual report of the CEQ.*

The cost estimates are primarily based on the assumption that the deadlines and standards established in the Clean Air Act (as amended) and the Federal Water Pollution Control Act (as amended) will be achieved. They, therefore, show a significant peaking prior to 1978. There is some evidence that these deadlines will not all be met, and that some expenditures will be delayed beyond 1978. In this case the macroeconomic effects of the programs would likely be less than projected in these analyses.

However, the cost estimates do not fully include the costs associated with meeting the 1983 standards established by the 1972 amendments to the Federal Water Pollution Control Act, and therefore, the actual macroeconomic impacts at the end of the decade 1973-82 may be greater than projected. It should also be noted that the initial computer runs for this study were made in the fall of 1974 and hence some of the baseline forecasts do not completely reflect subsequent changes in economic conditions.

Further macroeconomic analyses of this type are expected to be undertaken in the future as the abatement cost estimates are changed.

Edwin H. Clark, CEQ
Roy N. Gamse, EPA
January 1975

*The Council on Environmental Quality, Environmental Quality - 1974 (U.S. Government Printing Office, 1974), Appendix 1 to Chapter 2.

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INTRODUCTION

This report represents a continuing joint effort on the part of the Council on Environmental Quality (CEQ), the Environmental Protection Agency (EPA) and Chase Econometric Associates, Inc. to measure and assess the cost and economic effect of meeting existing pollution abatement standards through 1982. As has been the case in the past, the figures for pollution costs are segmented by air and water, divided into investment and annualized costs, and are made available on an annual basis for the 1973-1982 period. These figures were supplied to us by EPA and CEQ. We then used the methodology which we developed in previous similar reports to determine the effect on prices, output, and employment at both the macroeconomic and industry levels.

The text of this report follows in broad outline the study entitled The Economic Impact of Pollution Control: Macroeconomic and Industry Reports which we prepared for the EPA in July, 1973. In view of the basic similarity in methodology, some of the more esoteric sections of the report have been dropped, thus resulting in a somewhat briefer treatise; however, all of the essential ingredients have been retained. Section I of this report contains the methodology and assumptions used in the study; the actual results are summarized in Section II. We thus turn first to an outline of the general approach.

In the latter half of the 1973-1982 decade the effect on prices is reduced. By 1982 the cumulative price differentials are only 2.4%, 0.9%, and 0.2%. This reduction in the price differentials results from a substantial reduction in investment and, in part, to the incremental slowdown in the economy. Thus, when averaged over the decade, the WPI increases 0.2% more, the GNP deflator 0.1% more, and the CPI 0.02% more with pollution control expenditures.

The largest single-year increments occur in 1976, when the WPI rises 1.8% more and the GNP deflator 0.9% more because of pollution control expenditures. For the CPI, the largest single-year differential is in 1977, when it rises 0.6% more than it otherwise would have.

Impact on Economic Growth

The stimulus of increased expenditures on pollution control growth in the early years of the decade is projected to raise the rate of economic growth above what it would have otherwise been through 1976. The maximum differential in the rate of growth occurs in 1975, when constant dollar GNP will be 1.6% higher with pollution control expenditures. In the latter half of the decade, however, low levels of pollution control investment combined with a higher rate of inflation leads to slower economic growth. By 1979 real GNP is projected to be 2.0% below the baseline forecast. This difference gradually diminishes and by 1982 the real GNP ends up virtually the same in both forecasts.

Impact on Unemployment

In keeping with the pattern of overall economic growth, the unemployment rate is 0.4% lower in 1975 and 0.3% lower in 1976 than it otherwise would have been. However, it gradually rises to a level of 0.4% above the baseline forecast by 1979. The difference gradually decreases and returns almost to zero by 1982.

Investment

The cost estimates provided by EPA/CEQ show incremental pollution control investments amounting to approximately 5% of total plant and equipment expenditures through 1976. This investment is estimated to result in somewhat lower levels of other types of investment, the substitution taking place approximately at a rate of $0.40 reduction in all other private investment for every $1.00 of investment in pollution control plant and equipment.[2] However, the housing sector usually accounts for the majority of the reduced investment because of its greater sensitivity to the cost and availability of borrowed funds. This impact depends very much on the particular fiscal and monetary policy being pursued by the government. The combined effects of slower economic growth, greater credit stringency, and the increased cost of capital reduce annual investment in plant and equipment some 4.8% below the baseline level in 1979; this difference declines to 2.5% by 1982. Housing starts decline by as much as 15.3% in 1978, although this difference disappears by the end of the forecast period.

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[2]This result is based on a number of simulations performed with the Chase Econometrics macro model under different assumptions about underlying economic conditions.

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INTRODUCTION

This study represents an updating and continuation of the work done in previous years by Chase Econometrics for the Environmental Protection Agency (EPA) and the Council on Environmental Quality (CEQ) in assessing the macroeconomic impact of Federal environmental programs.[1] The analysis uses abatement cost estimates for the period 1973-1982 supplied by EPA and CEQ for air and water pollution abatement; these figures are given in Table 1. The estimates include capital investment, annualized capital costs, and operating and maintenance costs for each of the years in the period of analysis, and are disaggregated by two-digit industry. The cost estimates are consistent with the "incremental abatement costs" estimates published in the CEQ 1974 annual report.

The analysis was performed using the Chase Econometrics macroeconomic and input/output models, which are linked together into a single solution algorithm. The Chase model system thus allows analysis of both the impacts that different industries have on one another and on the interaction between pollution control expenditures and general economic factors such as the rate of growth, inflation, unemployment, and financial markets.

Most of the analysis is based upon the EPA/CEQ estimated level and timing of costs superimposed on a general cyclical economic scenario taken from a recent Chase Econometrics ten-year forecast. The impacts of the pollution control expenditures are estimated by comparing the economic forecasts including these expenditures with a forecast which is similar in every respect except that it excludes such additional environmental expenditures. It should be noted, however, that the inclusion of these expenditures involves several sets of adjustments to the model, which are discussed in greater detail in the Methodology and Assumptions section. However, an additional 11 simulations were also calculated using different cost estimates, alternative assumptions about the underlying economic scenario, the level of expenditures, and their timing over the ten-year period. These alternative scenarios are discussed in more detail later in this report.

PRINCIPAL CONCLUSIONS

Impact on Inflation

By 1978, when the bulk of the incremental investment in the industrial sector is complete, the wholesale price index will be 3.0% higher, the implicit GNP deflator will be 1.9% higher, and the consumer price index will be 1.2% higher than would have been the case in the absence of pollution control expenditures. These correspond to an average annual rate of increase of 0.6% for the WPI, 0.4% for the GNP deflator, and 0.24% for the CPI over this period.

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[1] The Economic Impacts of Meeting Exhaust Emission Standards, 1971-1980, October, 1971; The Economic Impact of Pollution Control Upon the General Economy, October, 1972; The Economic Impact of Pollution Control: Macroeconomic and Industry Reports, July, 1973.

POLLUTION ABATEMENT COSTS

The cost estimates used in this analysis are consistent with the most recent CEQ estimates of "incremental abatement costs" being published in its 1974 annual report. The CEQ defines "incremental" abatement costs as expenditures made to satisfy the requirements of Federal environmental legislation beyond what would have been spent for pollution control in the absence of this legislation. Some industries are shown to have negative investment for air pollution in the years following 1978, which means that the firms in those industries would have undertaken certain investment for pollution control in any case, but did so sooner because of Federal legislation.

The cost estimates, which are predominantly based upon cost estimates provided in the 1974 edition of The Cost of Clean Air and the 1973 edition of The Economics of Clean Water, are summarized in Table I. Those figures were made available to Chase Econometrics for 15 two-digit industries in the manufacturing sector, utilities, and public sector investment. Very small expenditures which were also given for agriculture and mining were combined into the appropriate manufacturing category. These figures were given on an annual basis for the years 1973 to 1982 and were separated into expenditures for air pollution and water pollution abatement. The estimates included investment cost, annual operation and maintenance costs, and total annual costs. Annual costs include depreciation, interest charges, and operating and maintenance expenditures. In addition, figures were supplied for the cost of meeting mobile source emission standards for automobiles.

In addition to the basic analysis using the cost estimates summarized in Table I, four other sensitivity analyses were run using different assumptions about the level or timing of costs. The first of these assumed that, on the average, capital investment would be 20% less than estimated, but that operating and maintenance costs would be 15% higher. This adjustment was made to reflect the impact of an increased emphasis on process changes rather than end-of-the-pipe treatment for pollution abatement. The EPA/CEQ cost estimates (predominantly) assume "end-of-the-pipe" treatment.

The second cost sensitivity scenario assumed that all costs were increased by 25% in order to estimate the likely macroeconomic impact if the EPA/CEQ estimates were significantly understated. The third cost sensitivity scenario involved an "evening out" of costs over the ten-year period -- and a delay of some costs beyond the period -- in order to determine the impact of a delay in implementing the current compliance dates. Finally, because of the sharp drop in housing starts in some years, we returned the level of housing activity to its baseline level in order to determine what the effect of this policy might be when applied in conjunction with the pollution control expenditures.

METHODOLOGY AND ASSUMPTIONS

The baseline values for the overall economic scenario are taken from the Chase Econometrics long-term macroeconomic outlook. In this forecast we predict a continuation of the recession throughout 1974 and a rise in the rate of unemployment continuing into 1975. After that, the economy gradually returns to a 4½% rate of unemployment in 1978 and remains at that level through 1980. This baseline projects another small business cycle from 1980 to 1983, but the unemployment rate returns to 4½% by 1983. The indicated growth rate for real GNP

TABLE I

ESTIMATED INCREMENTAL POLLUTION CONTROL EXPENDITURES, 1973-1982

	Air Pollution Abatement Costs 1973-77		Water Pollution Abatement Costs 1973-77		Air Pollution Abatement Costs 1978-82		Water Pollution Abatement Costs 1978-82	
	Investment	Annual	Investment	Annual	Investment	Annual	Investment	Annual
Food & Kindred Products [a]	1188	577	1448	1665	-56	504	119	2483
Textiles	0	0	417	486	0	0	34	726
Lumber	0	0	545	964	0	0	45	1466
Paper & Paper Products	130	195	974	760	-6	227	80	1105
Chemicals	285	306	1340	860	-14	338	110	1228
Petroleum [b]	565	560	966	702	-27	611	79	1014
Rubber & Misc. Plastic Products	0	0	214	399	0	0	18	608
Leather	0	0	126	143	0	0	10	214
Stone, Clay & Glass	195	290	616	231	-9	336	51	305
Iron & Steel	2479	1424	749	257	-118	1338	61	321
Primary Nonferrous Metals	946	1237	286	224	-45	1412	24	340
Fabricated Metals	0	0	482	253	0	0	40	352
Nonelectrical Machinery	0	0	376	210	0	0	31	295
Electrical Machinery	0	0	306	145	0	0	25	200
Transportation Equipment	0	0	238	103	0	0	20	140
Total Industrial	5786	4589	9083	7402	-275	4766	747	10797
Utilicies [c]	8861	10575	1925	754	1867	17440	2476	2319
Public	1314	1701	17900	7990	407	2702	-3150	10868
Total Fixed Source	15963	16865	28908	16146	1999	24908	73	23984
Mobile Source emission controls	10900	21150			20370	53280		

[a] includes feedlots and grain handling

[b] includes coal cleaning and natural gas production

[c] includes residential/commercial/industrial heating

All figures are in millions of 1973 dollars.

The definitions of investment and annual costs are given on page 3.

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averages 4.0% for the period 1975-1980 and 3.7% for the period 1981-1983. The rate of inflation as measured by the consumer price index averages 6.5% from 1975 to 1980 and 5.2% from 1981 to 1983.

Other major factors of the baseline forecast include the assumption that both the Federal and state and local government budgets will remain approximately in balance over the coming decade, with an average annual surplus of $3 billion over this period. The personal savings rate will average approximately 7½% for the period, representing an increase from the postwar average of 6½%; this will be due primarily to a higher average rate of inflation. New car sales will increase from a low level of 9.1 million units in 1974 to 11.2 million in 1976 and then rise slowly from that point to 12.8 million units in 1983. Housing starts will rebound from a low level of 1.4 million units this year to 1.9 million units in 1976 and will remain at approximately this level for the rest of the decade, but will not surpass the figure of 2.05 million starts recorded in 1973. Short-term interest rates will decline from present peak levels, but long-term interest rates will continue to rise and will average approximately 11% over the decade.

An alternative scenario, called the "full employment baseline" is not vastly different from the cyclical baseline. The EPA/CEQ provided guidelines to Chase Econometrics which stated that the real growth rate should average 4.6% per year for the 1975-80 period and 3.2% per year for the 1981-83 period. Furtnermore, it was stipulated that the unemployment rate should average 5.4% in 1975 and 3.9% in both 1980 and 1983. We have maintained these conventions in solving for the baseline full employment scenario. As we move to higher rates of employment, the rate of price increase is slightly larger. Thus the consumer price index increases at a 6.7% annual rate during the forecast period, compared to a 6.0% increase in the baseline forecast. Similarly, the implicit GNP deflator rises at 6.5% instead of 5.8%, and the wholesale price index rises at 5.8% instead of 5.0%. The model has been adjusted so that real GNP rises at an average rate of 4.1% compared to 3.9% in the cyclical baseline case. Other variables are not significantly affected; the personal savings rate remains around 7½% and housing starts average just under 2 million units per year, although new passenger car sales rise about 1% a year faster.

We now consider the major steps which were taken to enter the EPA pollution cost figures into the Chase Econometrics industry and macro models. These can be briefly summarized as follows:

1) Enter the estimated investment costs for each industry into the model as an addition to the year by year demand for plant and equipment investment. These adjustments have two effects: (a) they are added directly to the investment functions in the model (see (7) below), and (b) they increase the asset base on which firms must earn the normal rate of return, hence resulting in higher prices.

2) Enter the annual operation and maintenance costs and interest costs on pollution control investments into the model as an increase in each industry's production costs.

3) Apply "markup" factors to the increase in production costs, including capital depreciation, interest charges, and operation and maintenance, to determine the increase in prices. The markup factors, which represent the proportion of increased costs passed along as higher prices, have already been calculated on an industry by industry basis in the Chase Econometrics industrial models. The markups in general range from 0.8 to 1.0. A markup factor of 1.0 indicates that the average firm in the industry will be able to just recover all the increased costs through product prices.

4) Calculate the effect which these price increases will have on all industries. The previous step calculated only the direct effect of pollution controls on prices; that is, the amount that the price of steel (e.g.) rises because the steel industry invests in pollution control plant and equipment. However, we must also consider the effects which an increase in steel will have on machinery, autos, and other steel-using industries. In other words, we must measure the indirect as well as the direct effects of the price increases in each industry.

5) Convert the price increases by final demand categories to price increases by aggregate demand categories. We use a reverse bridge matrix to go from the 40 categories of final demand to the aggregate demand components contained in the Chase Econometrics macro model.

6) Translate the price increases which come from the input-output table and the bridge matrix -- as given in (5) above -- into actual ex post price changes by using the markup factors at the macro level. Until this has been accomplished we do not yet know what changes in final product prices will be, since the cost increases may not be fully passed along. Thus we use the markup factors at the final demand level (consumption, investment, and exports) to determine what the price rise will be before taking into account interactive and dynamic factors. These markup factors range from 0.8 to 1.1.

7) Adjust for changes in fixed business investment due to pollution control expenditures. Since more investment will be needed, the constant terms in the investment functions should be raised accordingly. However, we adjust the rental cost of capital upward by the percentage of investment for pollution control because it will now take more investment to produce a given amount of output. Hence the required rate of return on investment for capacity expansion will have to increase to offset the zero financial return on the pollution control investments.

8) Labor productivity was adjusted downward through a decrease in capital stock to reflect the fact that the additional capital expenditures for pollution control do not increase output/manhour.

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9) The index of industrial production was increased to represent the manufacture of auto emission control devices.

10) The consumption of transportation services was increased because of higher operating and maintenance costs due to the catalytic converters and other pollution control devices.

11) Corporate profits were adjusted downward to take into account the added costs of pollution control. The existing profit functions would show an increase in profits if prices rose and unit labor costs, raw material prices, interest rates, output, and capacity utilization all stayed at the same level.

12) The amount of financing undertaken by the Federal government increased, reflecting higher government debt because of increased spending in the public sector, and the amount of bond financing was also increased by the amount necessary to keep the debt/equity ratio constant.

A final round of price and output changes were then obtained by solving the complete Chase macroeconomic model, taking into account the interactive and dynamic factors.

OPERATION OF MODEL

We now consider the interactive and dynamic features of the macroeconomic model. The additional plant and equipment expenditures for pollution control will reduce the amount of investment in the private sector undertaken for other purposes. Part of this effect has already been included by raising the value of the rental cost of capital term.[3] However, several other factors need to be taken into account. First, an increase in nominal investment will place greater pressure on the capital markets, thus increasing interest rates and lowering other investment. Second, the increased investment demand will cause an increase in the costs of construction materials, labor, and equipment which results in some decline in constant dollar investment for a given level of output and financial variables. Third, a significant substitution exists between residential and nonresidential construction. This substitution works through changes in three variables: credit availability, the cost of construction, and the availability of labor. Since housing is more sensitive than other construction to all three of these variables, it suffers the greatest decline when other sectors of investment increase. The average elasticity of substitution between pollution control expenditures and other fixed investment is approximately 0.4, as has already been mentioned. This value can reach even larger values during periods of overfull employment and stringent monetary policy, although it does not in these simulations.

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[3] The rental cost of capital is defined as $\frac{P_K\,(r+\delta)\,(1-uz-k)}{P_W\,(1-u)}$ where

P_K = supply price of capital goods
r = cost of borrowed funds
δ = depreciation rate
u = marginal statuatory tax rate
z = depreciation factor
k = investment tax credit rate
P_W = wholesale price index

It should be mentioned that a higher rate of inflation leads to a slower rate of growth in the economy for a number of other reasons. The most important link: a rise in the rate of inflation increases the savings rate and hence reduces consumption. According to the permanent income hypothesis, the marginal propensity to consume is lower for variable incomes than it is for fixed incomes. Yet clearly inflation penalizes those on fixed incomes at the expense of those on variable incomes. During inflation the decline in consumption by those on fixed incomes is not nearly matched by the increase in consumption by those on variable incomes -- even if we assume that income changes are the same -- and thus the savings rate rises. This is one of the important endogenous relationships in the macro model, and works through the income distribution and relative price terms in the consumption function. In addition there is a relative decline in durable purchases which is not balanced by the slightly higher spending on services.

The other channels by which a rise in prices lowers real output are more straightforward and require only brief commentary. First, for a given nominal money supply, higher prices must lead to a lower real money supply and hence an increase in interest rates unless there has been a specific offsetting shift in the liquidity preference function; this leads to the effects on investment which have already been discussed. Second, an increase in domestic prices for a given level of foreign prices leads to a deterioration in the net foreign balance in constant prices, although if the sum of the price elasticities of exports and imports is less than unity, the balance in nominal terms may increase. Third, a government budget which is fixed in current dollars buys fewer goods and services and generates less employment if prices increase. If the government attempts to retain its real purchasing power, it can do so only by creating additional money, which will in turn raise prices, or by borrowing additional funds, which will raise interest rates. We have chosen to assume that this latter route is operative, as indicated in our earlier discussion of constant adjustments.

All of these linkages reinforce the result that a rise in costs and prices will reduce aggregate demand and raise unemployment. As soon as this happens, however, secondary effects which act in the opposite direction begin to surface. A rise in unemployment will result in a lower level of wage increases in following years. Thus unit labor costs and prices will not rise as much for a given increase in productivity. In addition, the lower level of capacity utilization leads to lower markup factors. When these events begin to increase in importance, the rate of price increase starts to diminish. The decline in real GNP and employment, which was originally caused by higher prices, also begins to slacken. As this continues, prices and real GNP tend to return toward the level which would have occurred if the additional costs had not been added. Under a fairly wide variety of assumptions it is likely that the economy will eventually return to the level of output and employment which would have occurred in the absence of expenditures for pollution control, although prices will remain somewhat higher because of a lower level of productivity.

RESULTS OF ANALYSIS

Impact on Prices

The economic effects of pollution control expenditures are found to be rather modest. By 1978 the implicit GNP deflator is only 1.9% above the baseline case, the wholesale price index is only 3.0%, and the consumer price index only 1.2% above their baselines. The biggest price effect occurs in 1976, when the GNP deflator with pollution control costs rises 0.9% more than in the baseline scenario, and in 1977, when it rises 0.6% more. The difference in all other years is much less. Similarly, the wholesale price index rises an additional 1.9% in 1976 because of pollution control expenditures. This is the largest annual increase for any of the macroeconomic price indicators.

The fact that some price increase does occur is no surprise, since it is assumed that pollution control expenditures do not increase output per unit of labor or capital. The increased aggregate demand caused by the pollution control expenditures with no compensating increase in aggregate production inevitably results in higher prices. The amount of inflation will depend upon how much "slack" there is in the economy. At "full employment", the price increases caused by the additional demand could be very significant, while a sluggish economy will result in less increase. Even with a sluggish economy, however, there will be some price increase as firms pass on higher production costs in the form of higher prices, and as resources are competed away from other sectors to the production and installation of pollution control equipment.

Impact on Economic Growth

There has been a considerable amount of disagreement about whether pollution control expenditures on balance increase or diminish the rate of real growth and employment. Some economists have argued that the additional expenditures associated with pollution control investment will result in a higher growth rate and hence a higher level of employment. Our results support this analysis for the period before 1977. However, they also reveal that pollution controls contribute to the negative effect of higher inflation on real growth after 1977. This latter effect works through several different channels, which have already been described in the previous section.

As a result, we have a somewhat variegated picture of an incremental pattern of real growth over the forecast period. During the early years -- 1974 through 1976 -- real GNP is higher than the baseline solution and hence unemployment is lower. However, in 1977 and succeeding years the picture is reversed. First, less new investment is being added in 1977 and subsequent years. Second, the additional price increases resulting from the environmental expenditures set in motion forces that lead to a slower rate of real growth causing real GNP to be lower and unemployment higher in the perturbed solution in the years 1977 through 1982. The greatest decrement in real growth is reached in 1979, when the perturbed real GNP is 2.0% below the baseline solution.

After 1979, countervailing forces come into place. The lower rate of growth leads to a higher rate of unemployment, which in turn leads to smaller increases in wage rates, unit labor costs and prices. In addition, a decline in capacity

TABLE II

	1974	1975	1976	1977	1978	1979	1980	1981	1982
Gross National Product, Current Dollars									
Baseline projection	1405.1	1557.9	1738.9	1931.2	2149.6	2354.0	2555.8	2762.7	3008.9
With pollution control costs	1413.8	1586.8	1779.1	1962.0	2157.7	2344.5	2550.7	2775.8	3030.9
% Difference	.62	1.86	2.31	1.59	.38	-.40	-.20	.47	.73
Gross National Product, 1973 Dollars									
Baseline projection	1279.5	1303.1	1364.0	1435.2	1514.0	1570.6	1619.1	1664.3	1726.2
With pollution control costs	1286.9	1323.4	1379.0	1432.5	1491.8	1539.3	1594.9	1654.7	1723.4
% Difference	.58	1.56	1.10	-.19	-1.47	-1.99	-1.49	-.58	-.16
Implicit GNP Deflator, 1973 = 100									
Baseline projection	109.8	119.5	127.5	134.5	141.9	149.8	157.8	166.0	174.3
With pollution control costs	109.8	119.9	129.0	136.9	144.6	152.3	159.9	167.7	175.8
% Difference	.00	.33	1.18	1.78	1.90	1.67	1.33	1.02	.86
Consumer Price Index, 1973 = 100									
Baseline projection	110.9	120.5	128.6	136.4	144.6	152.9	161.3	169.9	178.6
With pollution control costs	111.0	121.0	129.4	138.0	146.4	154.6	162.5	170.6	179.0
% Difference	.09	.41	.62	1.17	1.24	1.11	.74	.41	.22
Wholesale Price Index, 1973 = 100									
Baseline projection	121.0	135.5	142.2	148.7	155.8	162.7	169.1	175.2	181.5
With pollution control costs	121.1	136.8	146.2	153.5	160.5	167.0	173.2	179.4	185.8
% Difference	.08	.96	2.81	3.23	3.02	2.64	2.42	2.40	2.37
Unemployment Rate, Percent									
Baseline projection	5.2	5.5	5.3	4.8	4.4	4.4	4.5	4.7	4.6
With pollution control costs	5.1	5.1	5.0	4.8	4.6	4.8	4.8	4.8	4.7
% Difference	-1.92	-7.27	-5.66	.00	4.55	9.09	6.67	2.13	2.17
Fixed Investment in Producers Durable Equipment, 1973 Dollars									
Baseline projection	91.4	95.7	102.8	109.3	116.7	121.8	126.4	130.4	135.9
With pollution control costs	93.8	102.4	107.4	110.2	114.4	117.7	123.0	129.0	135.4
% Difference	2.63	7.00	4.47	.82	-1.97	-3.37	-2.69	-1.07	-.37

TABLE II (cont'd)

	1974	1975	1976	1977	1978	1979	1980	1981	1982
Fixed Investment in Nonresidential Structures, 1973 Dollars									
Baseline projection	50.0	51.1	52.7	55.5	57.5	58.3	60.1	63.8	68.1
With pollution control costs	52.6	57.7	58.8	58.3	55.9	53.8	55.1	59.6	63.5
% Difference	5.2	12.92	11.57	5.05	-2.78	-7.72	-8.32	-6.58	-6.75
Housing Starts, Millions of Units									
Baseline projection	1.60	1.90	1.88	1.93	2.03	2.00	1.91	1.82	1.88
With pollution control costs	1.55	1.79	1.66	1.64	1.72	1.82	1.87	1.86	1.92
% Difference	-3.13	-5.79	-11.70	-15.03	-15.27	-9.00	-2.09	2.20	2.13
Percentage Growth Rate of GNP, 1973 Dollars									
Baseline projection	-1.2	1.8	4.7	5.2	5.5	3.7	3.1	2.8	3.7
With pollution control costs	-.6	2.8	4.2	3.9	4.1	3.2	3.6	3.7	4.2
Difference	.6	1.0	-.5	-1.3	-1.4	-.5	.5	.9	.5
Percentage Growth Rate of CPI									
Baseline projection	10.9	8.7	6.8	6.0	6.0	5.8	5.5	5.3	5.1
With pollution control costs	11.0	9.0	7.2	6.4	6.1	5.6	5.1	5.0	4.9
Difference	.1	.3	.4	.4	.1	-.2	-.4	-.3	-.2
Trade Balance, 1973 Dollars									
Baseline projection	8.9	6.0	6.0	7.4	9.1	11.1	12.5	13.8	14.7
With pollution control costs	8.7	5.0	5.6	7.3	8.8	10.5	11.7	13.0	14.0
% Difference	-2.25	-16.67	-6.67	-1.35	-3.30	-5.41	-6.40	-5.80	-4.76
Consumption of Autos and Parts, 1973 Dollars									
Baseline projection	49.3	55.0	59.4	61.8	62.3	61.7	61.3	61.6	62.5
With pollution control costs	49.4	55.3	58.8	60.4	59.7	59.2	59.7	61.0	62.0
% Difference	.20	.55	-1.03	-2.27	-4.17	-4.05	-2.61	-.97	-.80
Consumption of Other Durables, 1973 Dollars									
Baseline projection	75.1	75.9	79.1	82.4	86.3	89.5	91.9	94.4	97.4
With pollution control costs	75.2	76.9	80.3	83.2	86.2	88.4	91.0	94.2	97.6
% Difference	.13	1.32	1.52	.97	-.12	-1.23	-.98	-.21	.21

TABLE II (cont'd)

	1974	1975	1976	1977	1978	1979	1980	1981	1982
Consumption of Nondurables, 1973 Dollars									
Baseline projection	333.7	337.3	354.2	370.7	385.7	397.8	408.7	419.5	432.0
With pollution control costs	334.4	340.1	357.7	372.7	384.8	394.8	405.9	418.4	432.1
% Difference	.21	.83	.99	.54	-.23	-.75	-.69	-.26	.02
Consumption of Services, 1973 Dollars									
Baseline projection	336.5	340.5	352.7	370.4	393.2	411.4	425.3	437.3	450.5
With pollution control costs	337.3	343.8	357.0	373.4	393.0	407.9	421.1	436.0	452.2
% Difference	.24	.97	1.22	.81	-.05	-.85	-.99	-.30	.38
Disposable Personal Income, Current Dollars									
Baseline projection	985.0	1089.4	1211.4	1345.8	1488.4	1629.7	1772.7	1920.8	2088.4
With pollution control costs	988.8	1104.2	1236.0	1370.3	1503.8	1633.0	1772.3	1925.1	2095.0
% Difference	.39	1.36	2.03	1.82	1.03	.20	-.02	.22	.32
Corporate Profits Before Taxes, Current Dollars									
Baseline projection	142.2	137.1	158.3	181.8	209.2	227.8	247.7	267.1	294.9
With pollution control costs	145.3	146.8	165.3	179.1	198.0	213.8	236.6	261.4	290.1
% Difference	2.18	7.08	4.42	1.49	-5.35	-6.15	-4.48	-2.13	-1.63
Corporate Profits After Taxes, Current Dollars									
Baseline projection	86.1	78.6	90.8	103.4	121.0	133.0	145.6	158.0	175.4
With pollution control costs	88.0	84.4	95.0	101.8	114.2	124.7	139.0	154.5	172.5
% Difference	2.21	7.38	4.63	-1.55	-5.62	-6.24	-4.53	-2.22	-1.65
Aa Corporate Bond Rate for New Issues									
Baseline projection	9.58	10.59	10.97	11.47	10.97	11.01	11.03	10.97	10.87
With pollution control costs	9.70	11.29	11.85	12.47	11.77	11.44	11.23	11.16	11.18
% Difference	1.25	6.61	8.02	8.72	7.29	3.91	1.81	1.73	2.85
Index of Industrial Production, 1973 = 100									
Baseline projection	100.3	103.6	109.7	115.2	120.9	124.6	127.9	131.0	135.6
With pollution control costs	101.2	106.1	111.7	115.6	119.4	122.1	126.1	130.5	135.6
% Difference	.90	2.41	1.82	.35	-1.24	-2.01	-1.41	-.38	.00

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utilization reduces the size of markups in several industries. Thus for the 1980-82 period the shortfall in real GNP averages only 0.7%, and in 1982 the perturbed real GNP has virtually returned to the baseline level.

Impact on Investment

Turning to the major components of investment, we find that constant dollar purchases of producers durable goods are up 7.0% in 1975, but most of this increase represents investment in pollution control equipment. Thereafter, there is a relative reduction in pollution control expenditures, and the difference declines to 0.8% in 1977 and -3.3% in 1979 before returning almost to zero. Nonresidential construction increases 13% in 1975 and 5% in 1977, but reaches a maximum negative decrement of -8.3% in 1980. These decrements are due entirely to higher costs and a lower level of economic activity, since incremental pollution control investment in total remains positive throughout the decade.

Housing starts are hard hit and decline by 5.8% in 1975, 11.7% in 1976, and 15% in both 1977 and 1978. After that the difference narrows and they are only 9% below the baseline solution by 1982. The impact on housing, of course, depends very much on the particular monetary and fiscal policies being pursued by the Federal government. The government, for instance, could take steps directly to aid the housing market. To determine the impact of such a policy on prices and GNP growth, we calculated additional simulation exercises in which we returned housing to its baseline level. We found that stimulating the housing industry simply resulted in reducing the amount of funds available to the remaining borrowing sectors, particularly fixed business investment, and hence had relatively little short-run effect on the overall macroeconomic picture.

Impact on Foreign Trade

The foreign trade balance in 1973 dollars declines slightly in all years of the simulation period, unlike other components of income and production which start with positive increments but then become negative around 1978. The major cause of this is the increased level of prices over the entire period. This factor is offset in part by fluctuations in economic activity. Hence in 1975, when both prices and domestic output are higher, the decrement is largest; higher prices reduce U. S. competitiveness in international markets, while higher output increases U. S. imports. In later years the factors work in opposite directions. Prices are still higher, but a lower level of output reduces the demand for imports. On balance, however, the price effects always outweigh the income effects.

Other Economic Impacts

The major components of consumption follow the pattern which might be expected. All sectors show an increase in 1974 and 1975 and a decrease for the period 1978-1981. Auto sales are relatively harder hit because of the mobile source emission controls and decline by a peak amount of 4.2% in 1978; this corresponds to about 500,000 cars.[4] They also remain below the baseline solution in 1982 when all other major components of consumption show slight positive increments. The change in auto sales is due to a combination of factors which include changes in relative

[4]The cost estimates underlying this analysis were based on the April 1973 implementation schedule announced by the administrator of EPA in April 1973 and therefore do not take account of subsequent modifications of this schedule which will reduce these costs.

prices, disposable income, the rate of unemployment, and credit conditions. Gasoline prices are explicitly included but other operations and maintenance costs are not included in the new car equation.

Disposable personal income (DPI) in current dollars is slightly above the baseline solution in all years except 1980. In constant dollars, it follows the general pattern of other economic variables; it is higher through 1977, lower for 1978 through 1981, and slightly positive in 1982. The actual changes in constant dollars can be calculated by subtracting the percentage changes in the CPI from the percentage changes in DPI. Corporate profits fluctuate much more on both a pretax and after-tax basis. They rise 7% higher in 1975 and 4½% higher in 1976 but then decline sharply to a maximum decrement of 6% in 1979. After 1979, as with other macroeconomic variables, the difference between the perturbed and the baseline solution return toward zero, the difference being only 1.6% in 1982. No measure for "constant dollar" corporate profits is given, since this term is not easily defined.

In the financial markets, the Aa corporate bond rate for new issues is above the baseline solution throughout the simulation period. It is higher by 0.7% (or a 6.6% increase) in 1975; the difference continues to widen to 1977, where the gap is a full 100 basis points (or an 8.7% increase). After that it diminishes somewhat but still remains 0.3% higher (or a 2.9% increase) by 1982. Finally, the index of industrial production follows much the same pattern as constant-dollar GNP, with the peak positive difference of 2.4% being recorded in 1975 and the peak negative difference of 2.0% occurring in 1979. The projected levels and differences in interest rates depend, of course, upon monetary policy.

Sensitivity Analyses

We now consider the results of alternative simulation analyses which tested changes in the underlying assumptions about the condition of the economy or about the level or timing of pollution abatement expenditures. First, we summarize the changes that occur when we superimpose the expected levels of pollution control costs on the "full employment" baseline. As would be expected under this scenario, the price increases are slightly larger although the differences are modest. For example, by 1982 we find that the wholesale price index has increased by about three-fifths, the implicit GNP deflator by about two-fifths, and the CPI by about one-fifth more than with the Chase cyclical economic scenario used in the earlier analyses. The declines in real GNP are also similar in nature although the timing pattern is somewhat different. The increase in producers durable equipment and nonresidential construction and the decline in housing starts all follow the same pattern.

The impacts under the "cyclical" and "full employment" cases are similar primarily because there is relatively little difference between the two economic scenarios. In particular, the cyclical scenario assumes that the unemployment rate averages approximately 4.5% whereas in the full employment scenario this rate moves from 4½% to 3.9% in 1980 and remains at that level. It is clear that somewhat greater differences would have been observed if we had run a true recession scenario with the unemployment rate as high as 6%. However, the alternative runs at full employment do indicate that the rise in prices, while somewhat greater, is not of major importance, although the difference is more significant for the WPI than for the CPI or GNP deflator.

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For the second sensitivity analysis, the assumed abatement costs were adjusted by reducing investment costs by 10% and increasing O&M costs by an average of 15%. The purpose of this scenario was to test the impacts of increased emphasis upon process change rather than end-of-the-pipe treatment as an abatement strategy. This scenario (with the Chase cyclical economic base case) shows price rises about one-fourth less than in the original analysis. Because prices rise less, the maximum decrement in real GNP which occurs in 1979 is less than two-thirds as great as in the original analysis. By 1982 the change in consumer prices is only one-tenth less, but for the GNP deflator it is one-fifth less, and the wholesale price index one-third less. The housing market declines by only two-thirds as much and the other disturbances to the baseline growth pattern are similarly restrained.

The third sensitivity analysis involved increasing all costs by 25% in order to test the impacts which could be expected in case the EPA/CEQ estimates were seriously understated. This analysis showed the wholesale price index rising over one-fourth more by 1982 than the standard case, and the implicit GNP deflator by one-sixth, but the CPI by less than one-twelfth. These appear to be paradoxical results in that the increase in prices is smaller than the additional increase in expenditures. However, this is because the economy, and therefore the Chase macroeconomic model, contain many nonlinear and dynamic effects. These nonlinearities are evident in the changes in prices and output for earlier years. For example, in 1975 the incremental change in the wholesale price index is two-fifths above the standard, and in 1976 the difference is about one-third. These larger than proportional price increases lead to a sharper than proportional decline in real output. For example, the decline in GNP in 1977 is over twice as large, and in 1978 it is two-thirds larger. Thus the higher than proportional price increases lead, as might well be expected, to higher than proportional declines in real production and increases in unemployment; thus increases in wage rates in future years are lower than the standard analysis, hence eventually leading to some mitigating factors affecting prices.

In the fourth sensitivity analysis the timing pattern of expenditures was evened out and in some cases extended beyond 1982 in order to test the impacts of extending implementation deadlines. As expected, phasing in the expenditures more evenly until 1982 does reduce the overall rate of price increase. In 1982, the WPI is one-third lower, the implicit GNP deflator is one-fifth lower than in the standard run, while the small increment in the CPI is not affected. The maximum decrement in GNP, which also occurs in 1979, is only about half as large, while the increase in the unemployment rate is only half as great. The decline in housing starts and in producers durable equipment purchases and nonresidential construction expenditures is only about half as much. Thus timing patterns are quite important; stretching out the expenditures reduces the effect on output and prices by almost half.

It could be argued that the very substantial decline in housing is not indicative of what would actually happen in the economy, since the government could take steps to aid the housing market. Thus in our last sensitivity analysis, we tested this possibility by returning housing to its baseline level in order to determine whether the effect in real growth and prices would be substantially different. However, we found that this was not the case. Adding funds to the housing market through action by the Federal government and its agencies simply resulted in reducing the amount of funds available to the capital goods sector and hence had relatively little effect on the overall macroeconomic picture.

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CONCLUSION

The figures supplied by EPA/CEQ on pollution control expenditures for the period 1973 to 1982 will have a noticeable but modest effect on the overall economy. During this ten-year period, prices will average approximately 0.2% a year higher than they would have in the absence of these expenditures, although in the early part of that period (1974-1977) the CPI increases an average of 0.3% more, the implicit GNP deflator increases an average of 0.4% more, and the WPI increases an average of 0.8% more per year. The maximum difference of 1.0% for prices is reached in 1976. These higher prices eventually result in a somewhat lower growth rate of GNP, with the maximum decrement of 2% reached in 1979, which in turn results in a rate of unemployment which is 0.4% higher. However, the differences gradually diminish so that by 1982 real growth and employment are at virtually the same levels which would have occurred in the absence of pollution control investment, while prices are only some 2% higher.

We also experimented with various alternative assumptions concerning the underlying economic scenario and the level and timing of expenditures. The increase in prices would be about two-fifths higher if the economy were operating at full employment throughout this period; however, this does not appear to be a near-term problem. An increase in expenditures of 25% would raise the incremental change in prices about two-fifths in the peak years and would also have a greater negative effect on real growth and employment. Finally, a stretching out of expenditures to level peak year purchases would reduce the economic effects on output and prices by as much as one-half.

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I. METHODOLOGY AND ASSUMPTIONS

A. OUTLINE OF GENERAL APPROACH

In this study we have combined the Chase Econometrics Macroeconomic Model and the Chase Econometrics version of INFORUM, the Inter-Industry Forecasting Model of the University of Maryland, to estimate the effects which pollution control expenditures will have on the overall economy and each major industry. Of primary interest are the effect on prices, output, and employment at both the macroeconomic level and industry level. Since this procedure is fairly complex, we outline the major steps first and then discuss each one in the following subsections.

1) Enter the estimated investment costs for each industry into the model as an addition to the year-by-year demand for plant and equipment investment. These adjustments have two effects: (a) they are added directly to the investment functions in the model (see (7) below), and (b) they increase the asset base on which firms must earn the normal rate of return, hence resulting in higher prices.

2) Enter the annual operation and maintenance costs and interest costs on pollution control investments into the model as an increase in each industry's production costs.

3) Apply "markup" factors to the increase in production costs, including capital depreciation, interest charges, and operation and maintenance, to determine the increase in prices. The markup factors, which represent the proportion of increased costs passed along as higher prices, have already been calculated on an industry-by-industry basis in the Chase Econometrics industrial models. The markups in general range from 0.8 to 1.0. A markup

factor of 1.0 indicates that the average firm in the industry will be able to just recover all the increased costs through product prices.

4) Calculate the effect which these price increases will have on all industries. The previous step calculated only the direct effect of pollution controls on prices; that is, the amount that the price of steel (e.g.) rises because the steel industry invests in pollution control plant and equipment. However, we must also consider the effects which an increase in steel will have on machinery, autos, and other steel-using industries. In other words, we must measure the indirect as well as the direct effects of the price increases in each industry.

5) Convert the price increases by final demand categories to price increases by aggregate demand categories. We use a reverse bridge matrix to go from the 40 categories of final demand to the aggregate demand components contained in the Chase Econometrics macro model.

6) Translate the price increases which come from the input-output table and the bridge matrix -- as given in (5) above -- into actual ex post price changes by using the markup factors at the macro level. Until this has been accomplished we do not yet know what changes in final product prices will be, since the cost increases may not be fully passed along. Thus we use the markup factors at the final demand level (consumption, investment, and exports) to determine what the price rise will be before taking into account interactive and dynamic factors. These markup factors range from 0.8 to 1.1.

7) Adjust for changes in fixed business investment due to pollution control expenditures. Since more investment will be needed, the constant terms in the investment functions should be raised accordingly. However, we adjust

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the rental cost of capital upward by the percentage of investment for pollution control because it will now take more investment to produce a given amount of output. Hence the required rate of return on investment for capacity expansion will have to increase to offset the zero financial return on the pollution control investments.

8) Labor productivity was adjusted downward through a decrease in capital stock to reflect the fact that the additional capital expenditures for pollution control do not increase output/manhour.

9) The index of industrial production was increased to represent the manufacture of auto emission control devices.

10) The consumption of transportation services was increased because of higher operating and maintenance costs due to the catalytic converters and other pollution control devices.

11) Corporate profits were adjusted downward to take into account the added costs of pollution control. The existing profit functions would show an increase in profits if prices rose and unit labor costs, raw material prices, interest rates, output, and capacity utilization all stayed at the same level.

12) The amount of financing undertaken by the Federal government increased, reflecting higher government debt because of increased spending in the public sector, and the amount of bond financing was also increased by the amount necessary to keep the debt/equity ratio constant.

A final round of price and output changes were then obtained by solving the complete Chase macroeconomic model, taking into account the interactive and dynamic factors.

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B. POLLUTION ABATEMENT COSTS

The cost estimates used in this analysis are consistent with the most recent CEQ estimates of "incremental abatement costs" being published in its 1974 annual report. The CEQ defines "incremental" abatement costs as expenditures made to satisfy the requirements of Federal environmental legislation beyond what would have been spent for pollution control in the absence of this legislation. Some industries are shown to have negative investment for air pollution in the years following 1978, which means that the firms in those industries would have undertaken certain investment for pollution control in any case, but did so sooner because of Federal legislation.

The cost estimates, which are predominantly based upon cost estimates provided in the 1974 edition of The Cost of Clean Air, the 1973 edition of The Economics of Clean Water, and a number of microeconomic industry studies performed in conjunction with the setting of effluent guidelines, are summarized in Table I. Those figures were made available to Chase Econometrics for 15 two-digit industries in the manufacturing sector, utilities, and public sector investment. Very small expenditures which were also given for agriculture and mining were combined into the appropriate manufacturing category. These figures were given on an annual basis for the years 1973 to 1982 in 1973 dollars and were separated into expenditures for air pollution and water pollution abatement. The estimates included investment cost, annual operation and maintenance costs, and total annual costs. Annual costs include depreciation, interest charges, and operating and maintenance expenditures. In addition, figures were supplied for the cost of meeting mobile source emission standards for automobiles.

The annual cost estimates given in Table I do not include depreciation allowances, and hence differ from the estimates of annual costs contained in

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CEQ's Environmental Quality -- 1974. However, to assure consistency with these published numbers, we have included depreciation allowances in the detailed tables given at the end of Section I. We have also used the depreciation allowance figures in our empirical analysis.

TABLE I

ESTIMATED INCREMENTAL POLLUTION CONTROL EXPENDITURES, 1973-1982

	Air Pollution Abatement Costs 1973-77		Water Pollution Abatement Costs 1973-77		Air Pollution Abatement Costs 1978-82		Water Pollution Abatement Costs 1978-82	
	Investment	Annual	Investment	Annual	Investment	Annual	Investment	Annual
Food & Kindred Products [a]	1188	577	1448	1665	-56	504	119	2483
Textiles	0	0	417	486	0	0	34	726
Lumber	0	0	545	964	0	0	45	1466
Paper & Paper Products	130	195	974	760	-6	227	80	1105
Chemicals	285	306	1340	860	-14	338	110	1228
Petroleum [b]	565	560	966	702	-27	611	79	1014
Rubber & Misc. Plastic Products	0	0	214	399	0	0	18	608
Leather	0	0	126	143	0	0	10	214
Stone, Clay & Glass	195	290	616	231	-9	336	51	305
Iron & Steel	2479	1424	749	257	-118	1338	61	321
Primary Nonferrous Metals	946	1237	286	224	-45	1412	24	340
Fabricated Metals	0	0	482	253	0	0	40	352
Nonelectrical Machinery	0	0	376	210	0	0	31	295
Electrical Machinery	0	0	306	145	0	0	25	200
Transportation Equipment	0	0	238	103	0	0	20	140
Total Industrial	5786	4589	9083	7402	-275	4766	747	10797
Utilities [c]	8861	10575	1925	754	1867	17440	2476	2319
Public	1314	1701	17900	7990	407	2702	-3150	10868
Total Fixed Source	15963	16865	28908	16146	1999	24908	73	23984
Mobile Source emission controls	10900	21150			20370	53280		

[a] includes feedlots and grain handling

[b] includes coal cleaning and natural gas production

[c] includes residential/commercial/industrial heating

All figures are in millions of 1973 dollars.

The definitions of investment and annual costs are given on page I.4.

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The figures for pollution control expenditures for the industrial sector, utilities, and the public sector are separated into two groups: 1973-77, which represents bringing all existing facilities up to then current emission control levels, and 1978-82, which represents primarily installation of pollution control equipment and plant for new facilities but also includes the 1982 water standards. The annual costs are a function of all present and previous investment for pollution control; hence they are proportionately much larger for 1978-82, when most of the plant and equipment has already been put in place. These figures are given by industry for air and water pollution control expenditures and are disaggregated by capital and annual costs. In all cases the numbers in this column are totals for the indicated time period, not yearly estimates.

It may also be useful to compare at least the total expenditures for each industry to those figures which we used in our previous study; these are taken from Table I.2 of that study and given in Table 2A. A comparison is given in Table 2B, where all numbers have been converted to 1973 dollars; it should be noted that the previous study included estimates only through 1980, and hence the 1973 study numbers, particularly the annualized figures, would be at least 20% lower for that reason.

We now use these figures from Table 1 for the industrial sector to calculate the amount that prices would increase in a given industry if the average rate of return on stockholders' equity before and after pollution control expenditures were to remain constant. We then adjust for the fact that firms will in general <u>not</u> be able to pass along the full cost increases by using actual markup factors for each industry.

TABLE 2A

1972 ESTIMATES OF INCREMENTAL POLLUTION CONTROL EXPENDITURES IN THE INDUSTRIAL SECTOR, 1973 - 1980

Industry	Air Pollution Abatement Costs		Water Pollution Abatement Costs		Air Pollution Abatement Costs		Water Pollution Abatement Costs	
	Investment	Annual	Investment	Annual	Investment	Annual	Investment	Annual
Food & Kindred Products	452	246	941	1398	120	309	270	696
Textiles	0	0	416	161	0	0	99	187
Lumber	0	0	225	33			9	48
Paper & Paper Products	144	113	591	798	36	106	290	858
Chemicals	267	200	1943	834	223	213	562	977
Petroleum	740	415	66	21	146	261	9	21
Rubber & Misc. Plastic Products	0	0	200	39	0	0	42	78
Leather	0		60	57	0		24	59
Stone, Clay & Glass	129	119	307	123	27	50	41	138
Iron & Steel	931	880	1162	492	334	740	586	1299
Primary Nonferrous Metals	1496	1132	45	42	180	440	33	82
Fabricated Metals	0		1359	582	0		48	114
Nonelectrical Machinery	0		479	198	0		15	60
Electrical Machinery	0		307	123	0		43	114
Transportation Equipment	0		102	81	0		21	70
Utilities	4971	3772	4052	2400	651	1302	531	1385
Total	9130	6877	12455	7382	1717	3421	2608	6186

All figures are in millions of 1971 dollars. Annual costs include depreciation; total costs do not.

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TABLE 2B

Total Cost of Pollution Control

Industry	1973 study [a]	1974 study [b]
Food & Kindred Products	4.71	7.93
Textiles	0.92	1.66
Lumber & Wood Products	0.33	3.02
Paper & Allied Products	3.12	3.47
Chemicals	5.55	4.45
Petroleum Refining	1.78	4.47
Rubber & Misc. Plastic Prods.	0.38	1.24
Leather	0.21	0.49
Stone, Clay & Glass	0.99	2.02
Iron & Steel	6.83	6.51
Primary Nonferrous Metals	3.67	4.42
Fabricated Metal Products	2.24	1.13
Nonelectrical Machinery	0.80	0.91
Electrical Machinery	0.62	0.68
Transportation Equipment	0.29	0.50
Total Industrial	32.44	42.90
Utilities	20.27	46.22
Public	n.a.	39.73
Grand Total	n.a.	128.85

[a] 1973-1980 only, reconverted to 1973 dollars
All figures in billions of 1973 dollars

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If we assume that the firms will have the same profit margins before and after pollution control costs, this can be expressed algebraically as follows. This assumption is relaxed later in the analysis.

This includes interest, depreciation, operating and maintenance costs

$$\frac{\pi_o}{E_o} = \frac{S_o p_o - W_o - R_o - TX_o - RM_o}{E_o}$$

$$\frac{\pi_1}{E_1} = \frac{S_o p_1 - W_o - R_1 - TX_1 - RM_o}{E_o + \delta 1}$$

$$TX = \tau(S_o p_o)$$

$$R = \rho K$$

where:

π = pretax profit

μ = marginal statutory tax rate on corporate profits

E = stockholders' equity

S = volume of sales

p = price index of product

W = wage bill

R = all fixed charges

TX = indirect business taxes

RM = raw material costs

$\delta = 1 - \frac{\text{debt}}{\text{equity}}$ ratio

τ = excise tax rate

ρ = fixed costs as a proportion of capital stock

K = capital stock

subscript o = base period (before pollution control emission)

subscript 1 = next period (after pollution control emission)

subscript $\pi_o = \pi_1$ and solving yields the following:

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$$\frac{S_o p_1 (1-\tau) - W_o - \rho(K_o + I) - RM_o}{E_o + \delta I} = \frac{S_o p_o (1-\tau) - W_o - \rho K_o - RM_o}{E_o}$$

$$S_o p_1 (1-\tau) = W_o + RM_o + \rho(K_o + I) + \left\{1 + \frac{\delta I}{E_o}\right\}\left\{S_o p_o (1-\tau) - W_o - \rho K_o - RM_o\right\}$$

$$p_1 = \frac{W_o + RM_o + \rho(K_o + I)}{(1-\tau)S_o} + \left\{1 + \frac{\delta I}{E_o}\right\}\left\{p_o - \frac{W_o - \rho K_o - RM_o}{(1-\tau)S_o}\right\}$$

$$p_1 - p_o = \frac{\delta I}{E_o} p_o + \frac{\rho I}{(1-\tau)S_o} - \left\{\frac{\delta I}{E_o}\right\}\left\{\frac{W_o + \rho K_o + RM_o}{(1-\tau)S_o}\right\}$$

$$\frac{p_1 - p_o}{p_o} = \frac{\delta I}{E_o}\left\{1 - \frac{(W_o + \rho K_o + RM_o)}{(1-\tau)S_o p_o}\right\} + \frac{\rho I}{(1-\tau)S_o p_o}$$

$$\frac{p_1 - p_o}{p_o} = \frac{\delta I}{E_o}\left\{1 - \frac{(1-\tau)\ S_o p_o - \pi_o)}{(1-\tau)S_o p_o}\right\} + \frac{\rho I}{(1-\tau)S_o p_o}$$

$$\frac{p_1 - p_o}{p_o} = \frac{\delta I}{E_o}\left\{\frac{\pi_o}{(1-\tau)S_o p_o}\right\} + \frac{\rho I}{(1-\tau)S_o p_o}$$

These are annualized costs

$\frac{\delta I}{E_o}$: fraction of investment which goes into equity

$\frac{\pi_o}{(1-\tau)S_o p_o}$: profit margin

We assume here that the debt/equity ratio remains constant. If not, the firm moves to a different debt/equity ratio and will have to pay a different interest rate. For example, if the added pollution control emission were financed completely by debt, $\delta = 0$, but then $R_1 = \rho(K_o + I) + (K_1 + I)\ \Delta r$, where Δr is the increase in the interest rate which the firm would have to pay on all its borrowed funds. Under perfect capital markets,

any decline in δ would be exactly offset by an increase in Δr, so that the percentage change in prices would be the same regardless of debt/equity structure.

The preceding algebra can also be expressed verbally. If the firm is facing an increase in capital expenditures due to pollution control costs, and is in an industry which faces a perfectly inelastic demand schedule but also has perfect competition, and if pollution control emission does not increase total product, then the firm will raise its prices an amount sufficient to:

a) cover the total dollar amount of the annualized costs associated with the increased investment, and

b) maintain the previous profit margin on the new investment base.

The figures used in the previous formula are given in Table 3 for each two-digit industry.

TABLE 3

Factors Used in Calculating Percentage Price Increases due to Pollution Control Costs

Industry	$1-\frac{D}{E}$	E_o	t	$\frac{\pi_o}{S_oP_o}$	S_oP_o	$\frac{\delta}{E_o}$	$\frac{\pi_o}{(1-t)S_oP_o}$	$\frac{1}{(1-t)S_oP_o}$
Food & Kindred Products	.459	30.805	.065	.047	143.551	.015	.050	.007
Textiles	.446	9.253	.006	.052	29.199	.048	.052	.034
Lumber	.367	8.214	.007	.100	27.387	.045	.101	.037
Paper & Paper Products	.497	11.536	.011	.094	26.503	.043	.095	.038
Chemicals	.604	39.910	.007	.119	83.581	.015	.120	.012
Petroleum	.711	66.592	.116	.098	97.806	.011	.111	.012
Rubber & Misc. Plastic Products	.385	9.055	.055	.071	26.410	.043	.075	.040
Leather	.515	1.790	.007	.047	6.795	.288	.047	.148
Stone, Clay & Glass	.581	11.660	.010	.081	26.063	.050	.082	.039
Iron & Steel	.489	17.873	.010	.068	40.815	.027	.069	.025
Primary Nonferrous Metals	.438	13.069	.010	.080	25.469	.034	.081	.040
Fabricated Metals	.539	16.320	.008	.073	55.082	.033	.074	.018
Nonelectrical Machinery	.584	38.786	.007	.102	88.419	.015	.103	.011
Electrical Machinery	.459	31.431	.005	.079	92.053	.015	.079	.011
Transportation Equipment	.619	38.673	.023	.070	127.162	.016	.072	.008
Utilities	.322	33.556	.072	.210	28.437	.010	.226	.038

$1 - \frac{D}{E} = \delta$ = 1- debt/equity ratio

E_o = stockholders' equity in the base period (1973.4)

t = excise tax rate

$\frac{\pi_o}{S_oP_o}$ = ratio of profits to sales in 1973

S_oP_o = sales in the base period (1973)

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C. MARKUP FACTORS

We now turn to the estimation of the proportion of the cost increases which will be reflected in increased prices. The previous equation for $\frac{\Delta P}{P}$ represents the price change which would occur in a perfectly competitive industry with a completely inelastic demand curve. However, the rise in prices may be smaller either because of a negative elasticity or because of oligopolistic conditions which could lead to a permanent loss of monopoly power. For this purpose we have used estimates of markups which are taken from the Chase Econometrics industry models. In general these equations are of the form:

$$P_j = a_0 + a_1 ULC_j + a_2 C_{p_j} + a_3 P_m \quad \ldots \quad j = 1,\ldots,N$$

where:

P = prices

ULC = unit labor costs

C_p = capacity utilization

p_m = price of material input (usually raw materials or import prices).

While the exact specification of the price equation varies among industries, all of them follow the same general structure.

An increase in the cost of (say) steel by X% will result in a price increase of $\alpha X\%$, where α is the markup factor. In the absence of any definite information to the contrary, we assume that the increase in price charged to all industries is the same. This is a very reasonable assumption except possibly for the particular industry itself, where the problem of transfer pricing arises. However, we are assuming that all transfer pricing is done using market rates, which is undoubtedly the most reasonable assumption in any case, so that this problem does not occur. The markup factors used are given in Table 4.

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TABLE 4

Markups for Industry Equations by I/O and SIC Category

I/O Category	Description	Markup Factor
1	Agriculture, forestry & fisheries	0.42
2	Mining	1.0
3	Construction	1.0
4	Ordnance & accessories	1.0
5	Food & kindred products	0.97
6	Tobacco manufacturers	0.97
7	Textiles	0.84
8	Apparrel	0.84
9	Paper and allied products	0.89
10	Printing and publishing	1.0
11	Drugs, cleaning and toilet preparation	0.94
12	Other chemicals	0.94
13	Petroleum refining	0.94
14	Rubber & misc. plastics	0.96
15	Lumber and wood products	0.84
16	Furniture and fixtures	0.81
17	Stone, clay & glass products	0.92
18	Leather products	0.96
19	Primary iron and steel mfg.	0.87
20	Primary nonferrous metal mfg.	0.93
21	Fabricated metal products	0.86
22	Nonelectrical machinery	0.90
23	Electrical consumer durables	0.83
24	Electrical mchy. & electronics	0.83
25	Motor vehicles & eqpt.	0.90
26	Other transportation eqpt.	1.0
27	Instruments	1.0
28	Misc. manufacturing	0.8
29	Railroads	1.0
30	Air freight transportation	1.0
31	Motor freight transportation	1.0
32	Communications	1.0
33	Electric utilities	1.0
34	Other utilities	1.0
35	Wholesale trade	1.0
36	Retail trade	1.0
37	Finance, insurance & real estate	1.0
38	Owner-occupied dwellings	1.0
39	Services	1.0
40	Rest of the world	1.0

Thus far we have answered the question "How much will the price of steel go up if the cost of steel goes up $1." But we have not yet attempted to answer the question "How much will the price of cars go up if the price of steel goes up by $1." Our next set of calculations deals with this question.

It is apparent that at least two types of information are needed. First, we must know the ratio of the cost of steel used in a car to the price of the automobile, and secondly, we must estimate the price markup factor for autos. The first point is easily met. We simply use the I/O coefficients -- including both direct and indirect effects -- as they appear in our updated version of the I/O matrix. While these coefficients change over time, and we do incorporate these changes in our actual industry forecasts, it is appropriate to use fixed coefficients for the weighting scheme.

In matrix notation:

Let $\hat{A}$ be the matrix of flows (e.g., dollars of steel used in the auto industry)

A is then the matrix of direct requirements per dollar of gross output

$$\left(\text{e.g., } \frac{\text{dollars of steel used in the auto industry}}{\text{total shipments of auto industry}}\right)$$

The matrix of total requirements (direct and indirect) per dollar of delivery to final demand, which is the set of coefficients used here, is then given by $(I-A)^{-1}$, where I is the identity matrix.

Since A = direct effects

$A^2 + A^3 + \ldots + A^N$ = indirect effects

and

$||\ A\ || < 1$, then $A + \ldots + A^n = \frac{1}{I-A}$

by the usual summation criteria.

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Thus in order to calculate the percentage price changes in each I/O category due to both the direct and indirect effects of the additional costs of pollution control equipment, we multiply the coefficients in the total requirements matrix by the price vector calculated from the rate of return equation and price markup vector.

In Table 5 we list three price changes for each industry classification. The first line, labelled original increase, represents the percentage cost increase resulting directly from pollution control expenditures. The second line, labelled increase w/markup, incorporates the markup factors given in Table 4. The third line, total increase, contains the total change in prices resulting from both the direct and indirect effects. It can be noted that prices for all 40 industries are affected indirectly, although only 16 are affected directly.

TABLE 5

DIRECT AND INDIRECT EFFECTS OF EPA COST PASS-THROUGHS, IN PERCENTS (Industry names are the same as in Table 4)

I-O	SIC		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	1-9	ORIGINAL INCREASE	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.092	.110	.137	.175	.206	.224	.232	.241	.248	.252
2	10-14	ORIGINAL INCREASE	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.115	.144	.184	.244	.292	.330	.345	.367	.384	.393
3	15-17	ORIGINAL INCREASE	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.058	.084	.102	.128	.147	.160	.167	.173	.179	.182
4	19	ORIGINAL INCREASE	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.145	.225	.268	.326	.371	.411	.431	.450	.471	.484
5	20	ORIGINAL INCREASE	.220	.310	.390	.470	.550	.570	.580	.590	.590	.600
		INCREASE W/MARKUP	.213	.301	.378	.456	.533	.553	.563	.572	.572	.582
		TOTAL INCREASE	.341	.473	.595	.730	.856	.902	.928	.944	.954	.969
6	21	ORIGINAL INCREASE	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.044	.060	.076	.096	.113	.123	.128	.132	.135	.136
7	22	ORIGINAL INCREASE	.210	.290	.380	.470	.530	.550	.540	.530	.510	.490
		INCREASE W/MARKUP	.189	.261	.342	.423	.477	.495	.486	.477	.459	.441
		TOTAL INCREASE	.418	.569	.737	.920	1.060	1.124	1.121	1.126	1.115	1.097
8	23	ORIGINAL INCREASE	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.228	.307	.397	.499	.578	.618	.621	.628	.626	.620
9	26	ORIGINAL INCREASE	.460	.690	.840	1.030	1.220	1.260	1.370	1.330	1.290	1.250
		INCREASE W/MARKUP	.373	.559	.680	.854	.988	1.021	1.110	1.077	1.045	1.013
		TOTAL INCREASE	.507	.752	.903	1.122	1.330	1.397	1.496	1.479	1.457	1.428
10	27	ORIGINAL INCREASE	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.147	.205	.256	.321	.380	.406	.428	.431	.431	.427
11	283-4	ORIGINAL INCREASE	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.134	.186	.234	.292	.343	.370	.380	.389	.395	.397
12	28x	ORIGINAL INCREASE	.420	.490	.610	.710	.920	.850	.830	.825	.820	.810
		INCREASE W/MARKUP	.301	.461	.573	.667	.771	.799	.780	.771	.771	.761
		TOTAL INCREASE	.455	.663	.828	.997	1.162	1.233	1.230	1.242	1.260	1.259
13	29	ORIGINAL INCREASE	.150	.220	.160	.290	.290	.300	.390	.420	.480	.540
		INCREASE W/MARKUP	.141	.207	.150	.273	.273	.282	.367	.395	.451	.508
		TOTAL INCREASE	.269	.370	.351	.542	.592	.639	.743	.794	.869	.938

TABLE 5 (continued)

14	30	ORIGINAL INCREASE	.180	.260	.340	.420	.470	.490	.490	.480	.460	.450
		INCREASE W/MARKUP	.173	.250	.326	.403	.451	.470	.470	.461	.442	.432
		TOTAL INCREASE	.368	.519	.667	.828	.951	1.011	1.018	1.022	1.015	1.005
15	24	ORIGINAL INCREASE	.430	.600	.770	.950	1.080	1.110	1.090	1.070	1.040	1.000
		INCREASE W/MARKUP	.361	.504	.647	.798	.907	.932	.916	.899	.874	.840
		TOTAL INCREASE	.541	.745	.958	1.188	1.361	1.420	1.410	1.405	1.386	1.351
16	25	ORIGINAL INCREASE	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.236	.335	.423	.521	.602	.650	.671	.690	.707	.713
17	32	ORIGINAL INCREASE	.240	.280	.350	.390	.470	.550	.590	.660	.700	.760
		INCREASE W/MARKUP	.230	.269	.336	.374	.451	.528	.566	.634	.672	.749
		TOTAL INCREASE	.356	.435	.549	.640	.765	.867	.914	.992	1.036	1.118
18	31	ORIGINAL INCREASE	.270	.380	.490	.600	.680	.700	.690	.670	.650	.630
		INCREASE W/MARKUP	.248	.350	.451	.552	.626	.644	.635	.616	.598	.580
		TOTAL INCREASE	.414	.564	.726	.906	1.046	1.107	1.112	1.113	1.107	1.095
19	331-2	ORIGINAL INCREASE	.510	.830	.980	1.160	1.320	1.470	1.710	1.860	2.080	2.210
		INCREASE W/MARKUP	.444	.722	.853	1.009	1.148	1.279	1.488	1.618	1.810	1.923
		TOTAL INCREASE	.721	1.126	1.345	1.620	1.859	2.075	2.353	2.544	2.804	2.957
20	33X	ORIGINAL INCREASE	.760	1.490	1.640	1.840	1.960	2.160	2.180	2.220	2.260	2.300
		INCREASE W/MARKUP	.707	1.376	1.525	1.711	1.823	2.009	2.027	2.065	2.102	2.139
		TOTAL INCREASE	1.171	2.174	2.443	2.790	3.016	3.335	3.378	3.459	3.533	3.597
21	34	ORIGINAL INCREASE	.080	.110	.140	.170	.190	.190	.180	.180	.170	.160
		INCREASE W/MARKUP	.069	.095	.120	.146	.163	.163	.155	.155	.146	.138
		TOTAL INCREASE	.537	.516	.621	.750	.851	.928	.981	1.030	1.081	1.109
22	35	ORIGINAL INCREASE	.040	.060	.070	.090	.090	.090	.090	.090	.080	.080
		INCREASE W/MARKUP	.036	.054	.063	.081	.081	.081	.081	.081	.072	.072
		TOTAL INCREASE	.217	.333	.397	.487	.544	.594	.631	.663	.689	.710
23	363-5	ORIGINAL INCREASE	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.198	.300	.365	.442	.506	.554	.580	.602	.626	.639
24	36X	ORIGINAL INCREASE	.030	.040	.050	.060	.070	.070	.070	.060	.060	.060
		INCREASE W/MARKUP	.025	.033	.041	.050	.058	.058	.058	.050	.050	.050
		TOTAL INCREASE	.179	.273	.329	.397	.453	.494	.521	.521	.538	.549
25	371	ORIGINAL INCREASE	.020	.020	.030	.030	.040	.040	.030	.030	.030	.030
		INCREASE W/MARKUP	.018	.018	.027	.027	.036	.036	.027	.027	.027	.027
		TOTAL INCREASE	.255	.372	.459	.549	.636	.696	.731	.771	.816	.843
26	37X	ORIGINAL INCREASE	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.202	.314	.376	.455	.516	.568	.598	.625	.654	.672
27	38	ORIGINAL INCREASE	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.139	.210	.255	.311	.357	.391	.405	.420	.433	.440
28	39	ORIGINAL INCREASE	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

TABLE 5 (continued)

		INCREASE W/MARKUP	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.200	.301	.365	.447	.512	.559	.579	.597	.613	.621
29	40	ORIGINAL INCREASE	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.037	.050	.066	.081	.094	.103	.112	.118	.126	.130
30	45	ORIGINAL INCREASE	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.062	.085	.094	.129	.147	.160	.175	.184	.196	.205
31	42	ORIGINAL INCREASE	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.034	.044	.056	.072	.085	.095	.098	.103	.107	.109
32	46	ORIGINAL INCREASE	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.047	.057	.078	.099	.120	.137	.142	.151	.158	.161
33	48	ORIGINAL INCREASE	3.190	3.500	4.710	6.570	8.130	9.420	9.760	10.520	11.020	11.280
		INCREASE W/MARKUP	3.190	3.500	4.710	6.570	8.130	9.420	9.760	10.520	11.020	11.280
		TOTAL INCREASE	3.865	3.806	5.119	7.158	8.831	10.230	10.600	11.424	11.966	12.248
34	491	ORIGINAL INCREASE	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.059	.072	.092	.123	.148	.167	.174	.185	.194	.198
35	49X	ORIGINAL INCREASE	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.050	.060	.077	.104	.126	.142	.149	.158	.166	.168
36	50	ORIGINAL INCREASE	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.085	.098	.129	.176	.215	.246	.256	.273	.284	.290
37	52-59	ORIGINAL INCREASE	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.051	.060	.078	.106	.129	.147	.153	.163	.169	.173
38	60-69X	ORIGINAL INCREASE	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.010	.014	.018	.023	.026	.029	.030	.031	.032	.032
39	64	ORIGINAL INCREASE	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.086	.105	.136	.181	.218	.246	.255	.270	.280	.286
40	70-89	ORIGINAL INCREASE	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		INCREASE W/MARKUP	.300	.000	.000	.000	.000	.000	.000	.000	.000	.000
		TOTAL INCREASE	.114	.151	.189	.243	.288	.315	.328	.341	.350	.356

Chase Econometrics

The price increases which we have calculated above are not recorded in the market place until the goods and services are actually sold. No one buys "final demand of the food industry" as such; they buy food, beverages, or other edible products. In calculating the price increases for the consumer price index or GNP deflator, we want to make sure that we do not count each price increase more than once. A price increase of 2% in steel and 1% in cars because steel prices went up is clearly not an overall increase of 3%.

Thus in order to calculate how much product prices are actually changing, we need first to convert the final demand prices to aggregate demand prices. In order to do this, we use a reverse bridge matrix, which consists of equations of the following type:

$$\Delta PCI_{FB} = b_1 \Delta P_{(I/O)_1} + \ldots + b_5 \Delta P_{(I/O)_{14}} + \ldots$$

where

PCI_{FB} = consumer price index for food and beverages

$P(I/O)_j$ = price index for j^{th} input/output commodity

The b_i's for these equations are given in supplementary tables to the 1967 I/O matrix* and hence do not have to be calculated by regression techniques.

Finally we include markup factors in the price equations for aggregate demand. The price changes calculated above are ex ante price increases, which is perhaps another way of saying that they are input price changes - the amount that prices would change only if there were 100% pass-along at the retail level and no change in capacity utilization. Just as we introduced markup factors at the industry level, we need to do so at the aggregate demand level as well. These markup factors are taken from the price equations of the Chase Econometrics macro model and are given in Table 6.

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* These tables appear in February 1974 Survey of Current Business.

Chase Econometrics

TABLE 6

Markup Factors of Price Equations for Aggregate Demand

Price Variable			
Consumption		**Investment**	
New Cars	0.90 [a]	Equipment	0.50
Tires and parts (price is exogenous)	1.0	Structures	*
Household appliances	1.05	Housing	*
Furniture and furnishings	1.08	**Exports**	
Other durables	0.98	Food and beverages	0.75
Food and beverages	0.85	Other goods	0.93
Clothing	1.01	Services	1.0
Other nondurables	0.83		
Housing services	0.89		
Other services	1.13		

[a] Taken from auto study done for EPA by Chase Econometrics

* Not applicable - Value added for construction industry is unaffected by pollution requirements; increase in the cost of materials is handled directly by inclusion of the wholesale price index in that equation.

A few comments are in order on Table 6. First, the markups on consumption are all close to unity, with those for nonauto durables and also consumption of services exceeding unity by slight amounts. Second, the increase in the wholesale price index, which is not shown in this table, is calculated directly from the increases in prices at the 40-sector level, incorporating the weights which are used to construct the WPI itself. Third, the markup factor for equipment appears to be unreasonably low. However, this equation also includes the term 0.86 * Δwholesale price index, (WPI). When this factor is included, the total markup for equipment is very close to 0.9.

Chase Econometrics

D. CONSTANT TERM ADJUSTMENTS IN THE MACROECONOMIC MODEL

The first and most straightforward adjustment is to raise the constant terms for plant and equipment spending by the amount of investment which was supplied by the EPA. These figures were then rebased to 1958 dollars to conform with the Chase Econometrics macro model. We then divided these amounts between equipment and plant spending. It was assumed that spending in the industrial sector for clean water was 85% construction and 15% equipment, with the proportions reversed for spending for clean air, the actual division makes very little difference in our results.

The additional plant and equipment expenditures for pollution control will reduce the amount of investment in the private sector undertaken for other purposes. Part of this effect has already been included by raising the value of the rental cost of capital term.* However, several other factors need to be taken into account. First, an increase in nominal investment will place greater pressure on the capital markets, thus increasing interest rates and lowering other investment. Second, the increased investment demand will cause an increase in the costs of construction materials, labor, and equipment which results in some decline in constant dollar investment for a given level of output and financial variables. Third, a significant substitution exists between residential and nonresidential construction. This substitution works through changes in three variables: credit availability, the cost of construction, and the availability of labor. Since housing is more sensitive than other construction to all three of these

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* The rental cost of capital is defined as $\frac{P_K (r+\delta) (1-uz-k)}{P_W (1-u)}$ where

P_K = supply price of capital goods
r = cost of borrowed funds
δ = depreciation rate
u = marginal statuatory tax rate
z = depreciation factor
k = investment tax credit rate
P_W = wholesale price index

Chase Econometrics

variables, it suffers the greatest decline when other sectors of investment increase. The average elasticity of substitution between pollution control expenditures and other fixed investment is approximately 0.4. This value can reach even larger values during periods of overfull employment and stringent monetary policy, although it does not in these simulations.

The adjustment for the decline in labor productivity is best handled through readjusting the capital stock so that it does not include the pollution control investment. We use a standard log-linear production of the form $\log\left(\frac{\text{labor}}{\text{input}}\right) = a_0 + a_1 \log(\text{output}) + a_2 \log\left(\frac{\text{capital}}{\text{stock}}\right) + a_3 (\text{trend})$, and can capture the relevant effect of introducing "nonproductive" investment into the system simply by not including that investment as a factor input with positive marginal product.

Note that such an adjustment would tend to increase the amount of labor demanded per unit of output. However, this is only a partial effect. The higher prices will result in less output and hence less demand for labor. On balance, unemployment is higher with pollution control costs than without because of the somewhat lower levels of output, although the differences are not substantial.

The inclusion of auto emission controls in the model poses another problem. Output and employment in the industry are related to number of new cars sold; yet clearly what is occurring here is an increase in the unit price of each car. Thus what we have done is to increase the index of industrial production by an amount proportional to the volume of the expenditures on auto emission control equipment as given in Table 7. These figures are multiplied by our baseline estimates of 10.0 million domestic car sales in these years, and then converted to a change in the industrial production index for manufacturing. The change is about 0.4 points on a basis of 1967 = 100.0. The change in employment is then directly related to the change in output.

Chase Econometrics

The EPA and CEQ have provided figures indicating annual costs which will be incurred as a result of pollution control devices on automobiles; these are given in Table 7. The operation and maintenance costs are then converted to billions of 1958 dollars and added to the equation for consumption of transportation services in the macro model. No adjustment is made for depreciation or implied interest costs, since these are not included in consumption of durables in the national income accounts.

TABLE 7

Pollution Control Costs for Mobile Source Emissions

	Number of cars sold	Cost/ car	Total investment in pollution control devices	Operation and maintenance costs	Capital charges
1973	11.7	83	0.97	1.74	0.38
1974	10.3	83	0.86	2.78	0.52
1975	11.3	178	2.01	3.21	0.87
1976	11.7	270	3.16	3.72	1.42
1977	11.9	328	3.90	4.43	2.08
1978	12.0	328	3.94	5.25	2.71
1979	12.1	328	3.97	5.98	3.30
1980	12.5	328	4.10	6.77	3.88
1981	12.6	328	4.13	7.58	4.43
1982	12.9	328	4.23	8.43	4.95

Columns (3)-(5) in billions of 1973 dollars; Column (1) in billions, Column (2) in dollars

It is also necessary to adjust the constant term for the profits equation. Ordinarily an increase in the spread between prices and unit labor costs would tend to raise profits. However, when the price increase is due to pollution control expenditures, this is clearly not the case. Inasmuch as higher prices are due to these additional costs, profits will not change at all, and inasmuch as firms cannot pass along the full cost increment, profits will be diminished. We have estimated that about 90% of costs associated with pollution control in the private sector can be passed along in the form of higher prices, as shown in Table 6; the other 10% represents a decline in profits.

Finally it is necessary to make some adjustment for the method of financing to be employed. In our simulations we have assumed that the Federal government uses deficit financing. This will result in greater demands on credit markets and hence raise the amount of outstanding Treasury bills, bonds, and notes. In addition, a certain amount of the additional private investment will be financed through the bond market. One of the key determinants of the bond yield is the percentage of financing done in the bond market. This proportion averages about 20% of total nonresidential investment in both the private and public sectors. Thus we have kept this 20% figure constant and have raised bond financing by the indicated amounts. The net effect is to raise bond yields by about 30 basis points.

At this point we solve the Chase Econometrics macroeconomic and industry models and compare the results with baseline solutions. These results are discussed in detail in Section II of this report.

INCREMENTAL INVESTMENT FOR POLLUTION CONTROL
(MILLION $)

SIC		CAPITAL-IN-PLACE, 1972			1973			1974		
		Air	Water	Total	Air	Water	Total	Air	Water	Total
02	Feedlots		135.60	135.60		124.31	124.31		128.12	128.12
20	Food & Kindred Prod.	145.50	182.86	328.36	148.16	167.63	315.79	249.50	172.77	422.27
22	Textile Mill Prod.		91.54	91.54		83.91	83.91		86.49	86.49
24	Lumber & Wood Prod.		119.52	119.52		109.57	109.57		112.92	112.92
26	Paper & Allied Prod.	27.33	213.51	240.84	27.83	195.73	223.56	46.87	201.73	248.60
28	Chemical	59.88	293.87	353.75	60.98	269.39	330.37	102.68	277.64	380.32
29	Petroleum Refining	108.53	211.92	320.45	110.51	194.26	304.77	186.09	200.22	386.31
30	Rubber & Misc. Plastics		46.94	46.94		43.03	43.03		44.34	44.34
31	Leather		27.56	27.56		25.27	25.27		26.04	26.04
32	Stone, Clay & Glass	41.01	135.07	176.08	41.76	123.82	165.58	70.32	127.61	197.93
33	Primary Metals									
331	Ferrous	520.13			529.65			891.89		
333	Nonferrous	198.56			202.20			340.49		
	Subtotal	718.69	227.02	945.71	731.85	208.11	939.96	1,232.38	214.49	1,446.87
34	Fabricated Metal		105.79	105.79		96.98	96.98		99.95	99.95
35	Nonelectrical Machinery		82.39	82.39		75.53	75.53		77.84	77.84
36	Electrical Machinery		67.16	67.16		61.57	61.57		63.46	63.46
37	Transportation		52.26	52.26		47.90	47.90		49.37	49.37
	Other:									
72	Dry Cleaning	18.73		18.73	19.07		19.07	32.11		32.11
51	Grain Handling	103.69		103.69	105.59		105.59	177.81		177.81
11/12	Coal Cleaning	1.49		1.49	1.51		1.51	2.55		2.55
13	Natural Gas Production	8.53		8.53	8.68		8.68	14.62		14.62
	Res/Comm/Ind Heating	624.62		624.62	636.06		636.06	1,071.07		1,071.07
	Subtotal, Industrial	1,858.00	1,933.01	3,851.01	1,892.00	1,827.01	3,719.01	3,186.00	1,882.99	5,068.99
49	Utilities	1,021.00	0.00	1,021.00	499.00	115.00	614.00	787.00	504.80	1,291.80
	Public	391.00	0.00	391.00	159.00	300.00	459.00	251.00	3,000.00	3,251.00
	Total	3,270.00	1,993.00	5,263.00	2,550.00	2,242.00	4,792.00	4,224.00	5,388.00	9,612.00
	Cumulative Air	3,270.00			5,820.00			10,044.00		
	Water		1,993.00			4,235.00			9,623.00	
	Total			5,263.00			10,055.00			19,667.00

INCREMENTAL INVESTMENT FOR POLLUTION CONTROL
(MILLION $)

SIC		1975			1976			1977		
		Air	Water	Total	Air	Water	Total	Air	Water	Total
02	Feedlots		128.53	128.53		127.98	127.98		109.41	109.41
20	Food & Kindred Prod.	145.81	173.32	319.13	105.17	172.58	277.75	44.72	143.53	188.25
22	Textile Mill Prod.		86.76	86.76		86.39	86.39		73.86	73.86
24	Lumber & Wood Prod.		113.28	113.28		112.80	112.80		96.43	96.43
26	Paper & Allied Prod.	27.39	202.37	229.76	19.76	201.51	221.27	8.40	172.27	180.67
28	Chemical	60.01	278.53	338.54	43.28	277.35	320.63	18.40	237.10	255.50
29	Petroleum Refining	108.76	200.86	309.62	78.44	200.01	278.45	33.36	170.98	204.34
30	Rubber & Misc. Plastics		44.49	44.49		44.30	44.30		37.87	37.87
31	Leather		26.12	26.12		26.01	26.01		22.24	22.24
32	Stone, Clay & Glass	41.09	128.02	169.11	29.64	127.47	157.11	12.60	108.97	121.57
33	Primary Metals									
331	Ferrous	521.25			375.96			159.85		
333	Nonferrous	198.99			143.53			61.02		
	Subtotal	720.24	215.18	935.42	519.49	214.26	733.75	220.87	183.17	404.04
34	Fabricated Metal		100.27	100.27		99.84	99.84		85.35	85.35
35	Nonelectrical Machinery		78.09	78.09		77.76	77.76		66.47	66.47
36	Electrical Machinery		63.66	63.66		63.39	63.39		54.19	54.19
37	Transportation		49.53	49.53		49.32	49.32		42.16	42.16
	Other:									
72	Dry Cleaning	18.77		18.77	13.54		13.54	5.76		5.76
51	Grain Handling	103.92		103.92	74.95		74.95	31.87		31.87
11/12	Coal Cleaning	1.49		1.49	1.07		1.07	.46		.46
13	Natural Gas Production	8.55		8.55	6.16		6.16	2.62		2.62
	Res/Comm/Ind Heating	625.97		625.97	451.49		451.49	191.96		191.96
	Subtotal, Industrial	1,862.00	1,889.01	3,751.01	1,342.99	1,880.97	3,223.96	571.02	1,604.00	2,175.02
49	Utilities	2,050.00	257.20	2,307.20	1,607.00	533.40	2,140.40	942.00	514.30	1,456.30
	Public	403.00	4,800.00	5,203.00	316.00	5,700.00	6,016.00	185.00	4,100.00	4,285.00
	Total	4,315.00	6,946.00	11,261.00	3,266.00	8,114.00	11,380.00	1,698.00	6,218.00	7,916.00
	Cumulative Air	14,359.00			17,625.00			19,323		
	Water		16,569.00			24,683.00			30,901.00	
	Total			30,928.00			42,308.00			50,224.00

INCREMENTAL INVESTMENT FOR POLLUTION CONTROL
(MILLION $)

SIC		1978			1979			1980		
		Air	Water	Total	Air	Water	Total	Air	Water	Total
02	Feedlots		48.72	48.72		12.25	12.25		3.54	3.54
20	Food & Kindred Prod.	2.22	65.59	73.91	-8.14	16.52	8.38	-9.87	4.77	-5.10
22	Textile Mill Prod.		32.89	32.89		8.27	8.27		2.39	2.39
24	Lumber & Wood Prod.		42.94	42.94		10.79	10.79		3.12	3.12
26	Paper & Allied Prod.	1.54	76.71	78.25	-1.53	19.28	17.75	-1.85	5.57	3.72
28	Chemical	3.38	105.57	108.95	-3.35	26.54	23.19	-4.06	7.67	3.61
29	Petroleum Refining	6.13	76.13	82.26	-6.07	19.14	13.07	-7.36	5.53	-1.83
30	Rubber & Misc. Plastics		16.86	16.86		4.24	4.24		1.22	1.22
31	Leather		9.90	9.90		2.49	2.49		.72	.72
32	Stone, Clay & Glass	2.32	48.52	50.84	-2.30	12.20	9.90	-2.78	3.52	.74
33	Primary Metals									
331	Ferrous	29.39			-29.11			-35.27		
333	Nonferrous	11.22			-11.11			-13.47		
	Subtotal	40.61	81.56	122.17	-40.22	20.50	-19.72	-48.74	5.92	-42.82
34	Fabricated Metal		38.01	38.01		9.55	9.55		2.76	2.76
35	Nonelectrical Machinery		29.60	29.60		7.44	7.44		2.15	2.15
36	Electrical Machinery		24.13	24.13		6.07	6.07		1.75	1.75
37	Transportation		18.77	18.77		4.72	4.72		1.36	1.36
	Other:									
72	Dry Cleaning	1.06		1.06	-1.05		-1.05	-1.27		-1.27
51	Grain Handling	5.86		5.86	-5.80		-5.80	-7.03		-7.03
11/12	Coal Cleaning	.08		.08	-.08		-.08	-.10		-.10
13	Natural Gas Production	.48		.48	-.48		-.48	-.58		-.58
	Res/Comm/Ind Heating	35.30		35.30	-34.96		-34.96	-42.36		-42.36
	Subtotal, Industrial	104.98	716.00	820.98	-103.98	180.00	76.02	-126.00	51.99	-74.01
49	Utilities	554.00	152.40	706.40	388.00	304.70	692.70	350.00	819.10	1,169.00
	Public	109.00	1,700.00	1,809.00	76.00	-150.00	-74.00	72.00	-1,400.00	-1,328.00
	Total	768.00	2,568.00	3,336.00	360.00	335.00	695.00	296.00	-529.00	-233.00
	Cumulative Air	20,091.00			20,451.00			20,747.00		
	Water		33,469.00			33,804.00			33,275.00	
	Total			53,560.00			54,255.00			54,022.00

INCREMENTAL INVESTMENT FOR POLLUTION CONTROL
(MILLION $)

SIC		1981 Air	1981 Water	1981 Total	1982 Air	1982 Water	1982 Total
02	Feedlots		-5.38	-5.38		-8.30	-8.30
20	Food & Kindred Prod.	-10.96	-7.25	-18.21	-12.22	-11.19	-23.41
22	Textile Mill Prod.		-3.63	-3.63		-5.60	-5.60
24	Lumber & Wood Prod.		-4.74	-4.74		-7.32	-7.32
26	Paper & Allied Prod.	-2.06	-8.46	-10.52	-2.29	-13.07	-15.36
28	Chemical	-4.51	-11.65	-16.16	-5.03	-17.99	-23.02
29	Petroleum Refining	-8.18	-8.40	-16.58	-9.11	-12.97	-22.08
30	Rubber & Misc. Plastics		-1.86	-1.86		-2.87	-2.87
31	Leather		-1.09	-1.09		-1.69	-1.69
32	Stone, Clay & Glass	-3.09	-5.35	-8.44	-3.44	-8.27	-11.71
33	Primary Metals						
331	Ferrous	-39.19			-43.67		
333	Nonferrous	-14.96			-16.67		
	Subtotal	-54.15	-9.00	-63.15	-60.34	-13.90	-74.24
34	Fabricated Metal		-4.19	-4.19		-6.48	-6.48
35	Nonelectrical Machinery		-3.27	-3.27		-5.04	-5.04
36	Electrical Machinery		-2.66	-2.66		-4.11	-4.11
37	Transportation		-2.07	-2.07		-3.20	-3.20
	Other:						
72	Dry Cleaning	-1.41		-1.41	-1.57		-1.57
51	Grain Handling	-7.81		-7.81	-8.71		-8.71
11/12	Coal Cleaning	-.11		-.11	-.12		-.12
13	Natural Gas Production	-.64		-.64	-.72		-.72
	Res/Comm/Ind Heating	-47.07		-47.07	-52.45		-52.45
	Subtotal, Industrial	-139.99	-79.00	-218.99	-155.99	-122.00	-277.99
49	Utilities	350.00	1,085.70	1,435.70	367.00	114.30	481.30
	Public	74.00	-1,600.00	-1,526.00	76.00	-1,700.00	-1,624.00
	Total	284.00	-593.00	-309.00	287.00	-1,708.00	-1,421.00
	Cumulative Air	21,031.00			21,318.00		
	Water		32,682.00			30,974.00	
	Total			53,713.00			52,292.00

ANNUAL COST OF POLLUTION CONTROL -- AIR
(MILLION $ -- 1973 $)

SIC		1973 DEPR	1973 INT	1973 O&M	1973 TOTAL	1974 DEPR	1974 INT	1974 O&M	1974 TOTAL
02	Feedlots								
20	Food & Kindred Prod.	31.79	20.99	19.88	72.66	56.77	36.34	35.44	128.55
22	Textile Mill Prod.								
24	Lumber & Wood Prod.								
26	Paper & Allied Prod.	5.97	3.94	15.58	25.49	10.66	6.83	27.77	45.26
28	Chemical	13.09	8.64	22.29	44.02	23.37	14.95	39.74	78.06
29	Petroleum Refining	23.71	15.65	34.92	74.28	42.35	27.10	62.25	131.70
30	Rubber & Misc. Plastics								
31	Leather								
32	Stone, Clay & Glass	8.96	5.91	23.10	37.97	16.00	10.24	41.18	67.42
33	Primary Metals								
331	Ferrous	113.66	75.02	74.13	262.81	202.96	129.89	132.15	465.00
333	Nonferrous	43.39	28.64	95.61	167.64	77.48	49.59	170.46	297.53
	Subtotal								
34	Fabricated Metal								
35	Nonelectrical Machinery								
36	Electrical Machinery								
37	Transportation								
	Other:								
72	Dry Cleaning	4.09	2.70	-2.95	3.84	7.31	4.68	-5.26	6.73
51	Grain Handling	22.66	14.96	5.37	42.99	40.46	25.90	9.58	75.94
11/12	Coal Cleaning	.32	.21	.27	.80	.58	.37	.48	1.43
13	Natural Gas Production	1.86	1.24	4.57	7.67	3.33	2.13	8.14	13.60
	Res/Comm/Ind Heating	136.50	90.10	192.30	418.90	243.73	155.99	342.83	742.55
	Subtotal, Industrial	406.00	268.00	485.07	1,159.07	725.00	464.01	864.76	2,053.77
49	Utilities	186.00	107.00	558.00	851.00	265.00	148.00	794.00	1,207.00
	Public	39.00	31.00	143.00	213.00	55.00	42.00	201.00	298.00
	Total	631.00	406.00	1,186.07	2,223.07	1,045.00	654.01	1,859.76	3,558.77

ANNUAL COST OF POLLUTION CONTROL -- AIR
(MILLION $ -- 1973 $)

SIC		1975 DEPR	1975 INT	1975 O&M	1975 TOTAL	1976 DEPR	1976 INT	1976 O&M	1976 TOTAL
02	Feedlots								
20	Food & Kindred Prod.	71.34	42.29	44.52	158.15	81.91	44.17	51.12	177.20
22	Textile Mill Prod.								
24	Lumber & Wood Prod.								
26	Paper & Allied Prod.	13.40	7.94	34.89	56.23	15.39	8.30	40.06	63.75
28	Chemical	29.36	17.40	49.93	96.69	33.71	18.18	57.33	109.22
29	Petroleum Refining	53.21	31.54	78.20	162.95	61.10	32.94	89.80	183.84
30	Rubber & Misc. Plastics								
31	Leather								
32	Stone, Clay & Glass	20.11	11.92	51.73	83.76	23.09	12.45	59.40	94.94
33	Primary Metals								
331	Ferrous	255.06	151.17	166.03	572.26	292.82	157.89	190.63	641.34
333	Nonferrous	97.36	57.71	214.15	369.22	111.79	60.27	245.89	417.95
	Subtotal								
34	Fabricated Metal								
35	Nonelectrical Machinery								
36	Electrical Machinery								
37	Transportation								
	Other:								
72	Dry Cleaning	9.18	5.44	-6.61	8.01	10.54	5.69	-7.59	8.64
51	Grain Handling	50.84	30.14	12.03	93.01	58.38	31.48	13.82	103.68
11/12	Coal Cleaning	.73	.43	.60	1.76	.84	.45	.69	1.98
13	Natural Gas Production	4.18	2.48	10.23	16.89	4.80	2.59	11.75	19.14
	Res/Comm/Ind Heating	306.26	181.54	430.71	918.51	351.64	189.61	494.55	1,035.80
	Subtotal, Industrial	911.03	540.00	1,086.41	2,537.44	1,046.01	564.02	1,247.45	2,857.48
49	Utilities	470.00	275.00	1,409.00	2,154.00	630.00	353.00	1,892.00	2,875.00
	Public	80.00	62.00	293.00	435.00	100.00	75.00	366.00	541.00
	Total	1,461.03	877.00	2,788.41	5,126.44	1,776.01	992.02	3,505.45	6,273.47

ANNUAL COST OF POLLUTION CONTROL -- AIR
(MILLION $ -- 1973 $)

SIC		1977 DEPR	1977 INT	1977 O&M	1977 TOTAL	1978 DEPR	1978 INT	1978 O&M	1978 TOTAL
02	Feedlots								
20	Food & Kindred Prod.	86.38	40.88	53.89	181.15	87.16	34.53	54.42	176.11
22	Textile Mill Prod.				66.14				
24	Lumber & Wood Prod.					16.37	6.49	42.65	65.51
26	Paper & Allied Prod.	16.23	7.68	42.23		35.87	14.21	61.03	111.11
28	Chemical	35.55	16.82	60.43	112.80	65.01	25.76	95.59	186.36
29	Petroleum Refining	64.43	30.49	94.66	189.58				
30	Rubber & Misc. Plastics								
31	Leather								
32	Stone, Clay & Glass	24.34	11.52	62.62	98.48	24.56	9.73	63.23	97.52
33	Primary Metals								
331	Ferrous	308.77	146.13	200.96	655.86	311.57	123.45	202.94	637.96
333	Nonferrous	117.88	55.79	259.22	432.89	118.95	47.13	261.76	427.84
	Subtotal								
34	Fabricated Metal								
35	Nonelectrical Machinery								
36	Electrical Machinery								
37	Transportation								
	Other:								
72	Dry Cleaning	11.12	5.26	-8.00	8.38	11.22	4.45	-8.08	7.59
51	Grain Handling	61.56	29.13	14.57	105.26	62.12	24.61	14.71	101.44
11/12	Coal Cleaning	.88	.42	.73	2.03	.89	.35	.73	1.97
13	Natural Gas Production	5.06	2.40	12.38	19.84	5.11	2.02	12.50	19.63
	Res/Comm/Ind Heating	370.81	175.49	521.34	1,067.64	374.17	148.26	526.46	1,048.89
	Subtotal, Industrial	1,103.01	522.01	1,315.03	2,940.05	1,113.00	440.99	1,327.94	2,881.93
49	Utilities	725.00	373.00	1,892.00	2,990.00	780.00	361.00	2,340.00	3,481.00
	Public	111.00	79.00	409.00	599.00	118.00	79.00	434.00	631.00
	Total	1,939.01	974.01	3,616.03	6,529.05	2,011.00	880.99	4,101.94	6,993.93

ANNUAL COST OF POLLUTION CONTROL -- AIR
(MILLION $ -- 1973 $)

SIC		1979 DEPR	1979 INT	1979 O&M	1979 TOTAL	1980 DEPR	1980 INT	1980 O&M	1980 TOTAL
02	Feedlots								
20	Food & Kindred Prod.	86.38	26.94	53.89	167.21	85.36	19.34	53.27	157.97
22	Textile Mill Prod.								
24	Lumber & Wood Prod.	16.23	5.06	42.23	63.58	16.03	3.63	41.75	61.41
26	Paper & Allied Prod.	35.55	11.09	60.43	107.07	35.13	7.96	59.75	102.84
28	Chemical	64.43	20.09	94.66	179.18	63.67	14.43	93.59	171.69
29	Petroleum Refining								
30	Rubber & Misc. Plastics								
31	Leather	24.34	7.59	62.62	94.55	24.06	5.45	61.91	91.42
32	Stone, Clay & Glass								
33	Primary Metals	308.77	96.30	200.96	606.03	305.13	69.15	198.69	572.97
331	Ferrous	117.88	36.76	259.22	413.86	116.49	26.40	256.28	399.17
333	Nonferrous								
	Subtotal								
34	Fabricated Metal								
35	Nonelectrical Machinery								
36	Electrical Machinery								
37	Transportation								
	Other:								
72	Dry Cleaning	11.12	3.47	-8.00	6.59	10.99	2.49	-7.91	5.57
51	Grain Handling	61.56	19.20	14.57	95.33	60.83	13.79	14.40	89.02
11/12	Coal Cleaning	.88	.28	.73	1.89	.87	.20	.72	1.79
13	Natural Gas Production	5.06	1.58	12.38	19.02	5.00	1.13	12.24	18.37
	Res/Comm/Ind Heating	370.81	115.65	521.34	1,007.80	366.44	83.04	515.43	964.91
	Subtotal, Industrial	1,103.01	344.01	1,315.03	2,762.05	1,090.00	247.01	1,300.12	2,637.13
49	Utilities	819.00	339.00	2,457.00	3,615.00	854.00	335.00	2,562.00	3,751.00
	Public	123.00	76.00	451.00	650.00	127.00	73.00	468.00	668.00
	Total	2,045.01	759.01	4,223.03	7,027.05	2,071.00	655.01	4,330.12	7,056.13

ANNUAL COST OF POLLUTION CONTROL -- AIR
(MILLION $ -- 1973 $)

SIC		1981 DEPR	1981 INT	1981 O&M	1981 TOTAL	1982 DEPR	1982 INT	1982 O&M	1982 TOTAL
02	Feedlots								
20	Food & Kindred Prod.	84.26	11.75	52.58	148.59	83.01	4.15	51.85	139.01
22	Textile Mill Prod.								
24	Lumber & Wood Prod.								
26	Paper & Allied Prod.	15.83	2.21	41.21	59.25	15.59	.78	40.63	57.00
28	Chemical	34.68	4.83	58.97	98.48	34.16	1.71	58.15	94.02
29	Petroleum Refining	62.85	8.76	92.37	163.98	61.91	3.10	91.08	156.09
30	Rubber & Misc. Plastics								
31	Leather								
32	Stone, Clay & Glass	23.75	3.31	61.10	88.16	23.39	1.17	60.25	84.81
33	Primary Metals								
331	Ferrous	301.22	41.99	196.10	539.31	296.74	14.84	193.37	504.95
333	Nonferrous	114.99	16.03	252.95	383.97	113.28	5.66	249.42	368.36
	Subtotal								
34	Fabricated Metal								
35	Nonelectrical Machinery								
36	Electrical Machinery								
37	Transportation								
	Other:								
72	Dry Cleaning	10.85	1.51	-7.81	4.55	10.68	.53	-7.70	3.51
51	Grain Handling	60.05	8.37	14.21	82.63	59.16	2.96	14.02	76.14
11/12	Coal Cleaning	.86	.12	.71	1.69	.85	.04	.70	1.59
13	Natural Gas Production	4.94	.69	12.08	17.71	4.87	.24	11.92	17.03
	Res/Comm/Ind Heating	361.73	50.43	508.73	920.89	356.35	17.82	501.64	875.81
	Subtotal, Industrial	1,076.01	150.00	1,283.20	2,509.21	1,059.99	53.00	1,265.33	2,378.32
49	Utilities	889.00	315.00	2,667.00	3,871.00	926.00	298.00	2,777.00	4,001.00
	Public	132.00	69.00	485.00	686.00	136.00	65.00	502.00	703.00
	Total	2,097.01	534.00	4,435.20	7,066.21	2,121.99	416.00	4,544.33	7,082.32
	CUMULATIVE TO 1982 --			Utilities		6,544.00	2,904.00	19,630.00	29,078.00
				Public		1,093.00		3,752.00	

ANNUAL COST OF POLLUTION CONTROL -- WATER
(MILLION $ -- 1973 $)

SIC		1973 DEPR	1973 INT	1973 O&M	1973 TOTAL	1974 DEPR	1974 INT	1974 O&M	1974 TOTAL
02	Feedlots	13.36	19.73	23.48	56.57	19.73	28.37	34.72	82.82
20	Food & Kindred Prod.	17.98	26.61	104.52	149.11	26.61	38.26	154.54	219.41
22	Textile Mill Prod.	9.00	13.32	37.61	59.93	13.32	19.15	55.61	88.08
24	Lumber & Wood Prod.	11.75	17.39	82.91	112.05	17.39	25.01	122.59	164.99
26	Paper & Allied Prod.	21.00	31.07	49.25	101.32	31.07	44.67	72.82	148.56
28	Chemical	28.90	42.76	48.62	120.28	42.76	61.49	71.90	176.15
29	Petroleum Refining	20.84	30.84	43.43	95.11	30.84	44.34	64.21	139.39
30	Rubber & Misc. Plastics	4.62	6.83	34.70	46.15	6.83	9.82	51.31	67.96
31	Leather	2.71	4.01	11.01	17.73	4.01	5.77	16.28	26.06
32	Stone, Clay & Glass	13.28	19.65	5.40	38.33	19.65	28.26	7.99	55.90
33	Primary Metals								
331	Ferrous								
333	Nonferrous								
	Subtotal	22.33	33.03	18.70	74.06	33.03	47.50	27.65	108.18
34	Fabricated Metal	10.40	15.39	11.64	37.43	15.39	22.13	17.21	54.73
35	Nonelectrical Machinery	8.10	11.99	10.39	30.48	11.99	17.24	15.36	44.59
36	Electrical Machinery	6.61	9.77	5.82	22.20	9.77	14.05	8.60	32.42
37	Transportation	5.14	7.61	3.52	16.27	7.61	10.94	5.21	23.76
	Other:								
72	Dry Cleaning								
51	Grain Handling								
11/12	Coal Cleaning								
13	Natural Gas Production								
	Res/Comm/Ind Heating								
	Subtotal, Industrial	196.02	290.00	491.00	977.02	290.00	417.00	726.00	1,433.00
49	Utilities	0.00	10.00	0.00	10.00	0.00	30.00	47.60	77.60
	Public	112.00	14.00	1,100.00	1,126.00	132.00	168.00	1,200.00	1,500.00
	Total								

ANNUAL COST OF POLLUTION CONTROL -- WATER
(MILLION $ -- 1973 $)

SIC		1975 DEPR	1975 INT	1975 O&M	1975 TOTAL	1976 DEPR	1976 INT	1976 O&M	1976 TOTAL
02	Feedlots	26.20	36.61	46.00	108.81	32.59	44.23	57.24	134.06
20	Food & Kindred Prod.	35.32	49.36	204.78	289.46	43.95	59.64	254.81	358.40
22	Textile Mill Prod.	17.68	24.71	73.69	116.08	22.00	29.85	91.69	143.54
24	Lumber & Wood Prod.	23.09	32.26	162.43	217.78	28.73	38.98	202.11	269.82
26	Paper & Allied Prod.	41.25	57.64	96.49	195.38	51.32	69.63	120.06	241.01
28	Chemical	56.77	79.33	95.27	231.37	70.63	95.84	118.54	285.01
29	Petroleum Refining	40.94	57.21	85.09	183.24	50.93	69.11	105.87	225.91
30	Rubber & Misc. Plastics	9.07	12.67	67.98	89.72	11.28	15.31	84.59	111.18
31	Leather	5.32	7.44	21.58	34.34	6.62	8.99	26.85	42.46
32	Stone, Clay & Glass	26.09	36.46	10.58	73.13	32.46	44.05	13.17	89.68
33	Primary Metals								
331	Ferrous								
333	Nonferrous								
	Subtotal	43.86	61.28	36.64	141.78	54.56	74.04	45.59	174.19
34	Fabricated Metal	20.44	28.56	22.80	71.80	25.43	34.50	28.37	88.30
35	Nonelectrical Machinery	15.92	22.24	20.36	58.52	19.80	26.87	25.33	72.00
36	Electrical Machinery	12.97	18.13	11.40	42.50	16.14	21.91	14.18	52.23
37	Transportation	10.09	14.11	6.92	31.12	12.56	17.04	8.61	38.21
	Other:								
72	Dry Cleaning								
51	Grain Handling								
11/12	Coal Cleaning								
13	Natural Gas Production								
	Res/Comm/Ind Heating								
	Subtotal, Industrial	385.01	538.01	962.01	1,885.03	481.70	649.99	1,197.01	2,328.70
49	Utilities	10.00	30.00	76.20	116.20	20.00	40.00	152.30	212.30
	Public	324.00	376.00	1,200.00	1,900.00	552.00	648.00	1,200.00	2,400.00
	Total					1,053.70	1,337.99	2,549.31	4,941.00

ANNUAL COST OF POLLUTION CONTROL -- WATER
(MILLION $ -- 1973 $)

SIC		1977 DEPR	1977 INT	1977 O&M	1977 TOTAL	1978 DEPR	1978 INT	1978 O&M	1978 TOTAL
02	Feedlots	38.03	49.94	66.85	154.82	40.48	50.55	71.16	162.19
20	Food & Kindred Prod.	51.29	67.34	297.59	416.22	54.59	68.17	316.75	439.15
22	Textile Mill Prod.	25.67	33.71	107.09	166.47	27.33	34.13	113.98	175.44
24	Lumber & Wood Prod.	33.52	44.02	236.05	313.59	35.68	44.56	251.25	331.49
26	Paper & Allied Prod.	59.89	78.63	140.22	278.74	63.74	79.60	149.25	292.59
28	Chemical	82.42	108.23	138.44	329.09	87.73	109.56	147.36	344.65
29	Petroleum Refining	59.44	78.05	123.65	261.14	63.27	79.00	131.61	273.88
30	Rubber & Misc. Plastics	13.16	17.29	98.80	129.25	14.01	17.50	105.16	136.67
31	Leather	7.73	10.15	31.36	49.24	8.23	10.28	33.38	51.89
32	Stone, Clay & Glass	37.88	49.74	15.38	103.00	40.32	50.35	16.37	107.04
33	Primary Metals								
331	Ferrous								
333	Nonferrous								
	Subtotal	63.68	83.61	53.25	200.54	67.78	84.64	56.68	209.10
34	Fabricated Metal	29.67	38.96	33.13	101.76	31.58	39.44	35.27	106.29
35	Nonelectrical Machinery	23.11	30.34	29.58	83.03	24.60	30.72	31.49	86.81
36	Electrical Machinery	18.84	24.74	16.57	60.15	20.05	25.04	17.63	62.72
37	Transportation	14.66	19.25	10.05	43.96	15.60	19.48	10.70	45.78
	Other:								
72	Dry Cleaning								
51	Grain Handling								
11/12	Coal Cleaning								
13	Natural Gas Production								
	Res/Comm/Ind Heating								
	Subtotal, Industrial	558.99	734.00	1,398.01	2,691.00	594.99	743.02	1,488.04	2,826.05
49	Utilities	80.00	30.00	338.10	448.10	30.00	90.00	247.60	367.60
	Public	716.00	784.00	1,300.00	2,800.00	784.00	916.00	1,300.00	3,000.00
	Total	1,354.99	1,548.00	3,036.11	5,939.10	1,408.99	1,749.02	3,035.64	6,193.65

ANNUAL COST OF POLLUTION CONTROL -- WATER
(MILLION $ -- 1973 $)

SIC		1979 DEPR	1979 INT	1979 O&M	1979 TOTAL	1980 DEPR	1980 INT	1980 O&M	1980 TOTAL
02	Feedlots	41.10	48.31	72.21	161.62	41.30	45.25	72.54	159.09
20	Food & Kindred Prod.	55.42	65.14	321.43	441.99	55.69	61.01	322.92	439.62
22	Textile Mill Prod.	27.74	32.61	115.67	176.02	27.88	30.54	116.20	174.62
24	Lumber & Wood Prod.	36.22	42.58	254.96	333.76	36.40	39.88	256.15	332.43
26	Paper & Allied Prod.	64.71	76.06	151.45	292.22	65.03	71.24	152.16	288.43
28	Chemical	89.06	104.69	149.54	343.29	89.50	98.05	150.23	337.78
29	Petroleum Refining	64.22	75.49	133.56	273.27	64.54	70.71	134.18	269.43
30	Rubber & Misc. Plastics	14.22	16.72	106.71	137.65	14.29	15.66	107.21	137.16
31	Leather	8.35	9.82	33.87	52.04	8.39	9.20	34.03	51.62
32	Stone, Clay & Glass	40.93	48.12	16.61	105.66	41.13	45.07	16.69	102.89
33	Primary Metals								
331	Ferrous								
333	Nonferrous								
	Subtotal	68.80	80.88	57.52	207.20	69.14	75.75	57.78	202.67
34	Fabricated Metal	32.06	37.69	35.79	105.54	32.22	35.30	35.95	103.47
35	Nonelectrical Machinery	24.97	29.35	31.95	86.27	25.09	27.49	32.10	84.68
36	Electrical Machinery	20.35	23.93	17.89	62.17	20.46	22.41	17.98	60.85
37	Transportation	15.84	18.62	10.86	45.32	15.92	17.44	10.91	44.27
	Other:								
72	Dry Cleaning								
51	Grain Handling								
11/12	Coal Cleaning								
13	Natural Gas Production								
	Res/Comm/Ind Heating								
	Subtotal, Industrial	603.99	710.01	1,510.02	2,824.02	606.98	665.00	1,517.03	2,789.01
49	Utilities	40.00	110.00	276.20	426.20	40.00	140.00	304.80	484.80
	Public	778.00	922.00	1,300.00	3,000.00	722.00	778.00	1,400.00	2,900.00
	Total	1,421.99	1,742.01	3,086.22	6,250.22	1,368.98	1,583.00	3,221.83	6,173.81

ANNUAL COST OF POLLUTION CONTROL -- WATER
(MILLION $ -- 1973 $)

SIC		1981 DEPR	1981 INT	1981 O&M	1981 TOTAL	1982 DEPR	1982 INT	1982 O&M	1982 TOTAL
02	Feedlots	41.03	41.57	72.06	154.66	40.62	37.63	71.35	149.60
20	Food & Kindred Prod.	55.33	56.06	320.80	432.19	54.77	50.74	317.60	423.11
22	Textile Mill Prod.	27.70	28.06	115.44	171.20	27.42	25.40	114.29	167.11
24	Lumber & Wood Prod.	36.16	36.64	254.46	327.26	35.80	33.16	251.92	320.88
26	Paper & Allied Prod.	64.60	65.46	151.15	281.21	63.96	59.24	149.65	272.85
28	Chemical	88.91	90.09	149.24	328.24	88.03	81.54	147.75	317.32
29	Petroleum Refining	64.12	64.97	133.29	262.38	63.48	58.80	131.97	254.25
30	Rubber & Misc. Plastics	14.20	14.39	106.50	135.09	14.06	13.02	105.44	132.52
31	Leather	8.34	8.45	33.80	50.59	8.26	7.65	33.47	49.38
32	Stone, Clay & Glass	40.87	41.41	16.58	98.86	40.46	37.48	16.41	94.35
33	Primary Metals								
331	Ferrous								
333	Nonferrous								
	Subtotal	68.69	69.60	57.40	195.69	68.00	62.99	56.83	187.82
34	Fabricated Metal	32.01	32.43	35.72	100.16	31.69	29.35	35.36	96.40
35	Nonelectrical Machinery	24.93	25.26	31.89	82.08	24.68	22.86	31.57	79.11
36	Electrical Machinery	20.32	20.59	17.86	58.77	20.12	18.64	17.68	56.44
37	Transportation	15.81	16.02	10.84	42.67	15.65	14.50	10.73	40.88
	Other:								
72	Dry Cleaning								
51	Grain Handling								
11/12	Coal Cleaning								
13	Natural Gas Production								
	Res/Comm/Ind Heating								
	Subtotal, Industrial	603.02	611.00	1,507.03	2,721.05	597.00	553.00	1,492.02	2,642.02
49	Utilities	80.00	180.00	390.50	650.50	90.00	180.00	400.00	670.00
	Public	658.00	742.00	1,400.00	2,800.00	590.00	710.00	1,400.00	2,700.00
	Total	1,341.02	1,533.00	3,297.53	6,171.55	1,277.00	1,443.00	3,292.02	6,012.02

ANNUAL COST OF POLLUTION CONTROL -- WATER
(MILLION $ -- 1973 $)

CUMULATIVE -- 1982

SIC		DEPR	INT	O&M	TOTAL
02	Feedlots			587.61	
20	Food & Kindred Prod.			2,615.75	
22	Textile Mill Prod.			941.26	
24	Lumber & Wood Prod.			2,074.83	
26	Paper & Allied Prod.			1,232.49	
28	Chemical			1,216.88	
29	Petroleum Refining			1,086.87	
30	Rubber & Misc. Plastics			868.39	
31	Leather			275.62	
32	Stone, Clay & Glass			135.17	
33	Primary Metals				
331	Ferrous				
333	Nonferrous				
	Subtotal			468.05	
34	Fabricated Metal			291.23	
35	Nonelectrical Machinery			260.01	
36	Electrical Machinery			145.61	
37	Transportation			88.35	
	Other:				
72	Dry Cleaning				
51	Grain Handling				
11/12	Coal Cleaning				
13	Natural Gas Production				
	Res/Comm/Ind Heating				
	Subtotal, Industrial			12,288.12	
49	Utilities				
	Public				
	Total				

Chase Econometrics

II. BASELINE FORECASTS AND ALTERNATIVE SIMULATIONS

A. BASELINE FORECASTS

In this part of the report we discuss the macroeconomic and industry impact of the pollution control expenditures given in Section I. However, in order to determine the magnitude of these disturbances it is first necessary to calculate a baseline forecast which is compatable in all respects with the perturbed simulation runs. We have prepared two such baseline forecasts in order to assess the nonlinear propensities of higher spending at different levels of unemployment and capacity utilization, and also because of the impossibility of predicting precise magnitudes of economic activity ten years in the future.

We consider first what we have called the cyclical baseline forecast, which is virtually identical to the Chase Econometrics long-term macroeconomic outlook. In this forecast we predict a continuation of the recession this year and the rise in the rate of unemployment to an average level of 5½% next year. After that, the economy returns to a 4½% rate of unemployment in 1978 and remains at that level through 1980. Some elements of cyclicality become apparent in the later years of the forecast, but the unemployment rate returns to 4½% by 1983. The indicated growth rate of real GNP averages 4.0% for the period 1975-1980 and 3.7% for the period 1981-1983. The rate of inflation as measured by the consumer price index averages 6.5% from 1975 to 1980 and 5.2% from 1981 to 1983. Other major factors of the baseline forecast include the assumption that the Federal government budget will remain approximately in balance over the coming decade, with an average annual surplus of $3 billion over this period. The personal savings rate will average approximately 7½% for the period, representing an increase from the postwar average of 6½%;

Chase Econometrics

this will be caused by a higher average rate of inflation. New car sales will increase from their low level of 9.4 million units this year to 11.2 million units in 1976 and then rise slowly from that point to 12.8 million in 1983. Housing starts will rebound from their low level of 1.4 million units in 1974 to 1.9 million units in 1976 and will remain at approximately this level for the rest of the decade, but will not surpass the figure of 2.05 million starts recorded in 1973. Short-term interest rates will decline from present peak levels, but long-term interest rates will continue to rise and will average approximately 11% over the decade. Two summary pages of the baseline forecast are given in Table 8.

The scenario described under the full employment baseline is not vastly different from the cyclical baseline. The EPA provided guidelines to Chase Econometrics which stated that the real growth rate should average 4.6% per year for the 1975-80 period and 3.2% per year for the 1981-83 period. Furthermore, it was stipulated that the unemployment rate should average 5.4% in 1975 and 3.9% in both 1980 and 1983. We have maintained these conventions in solving for a baseline full employment scenario. As we move to higher rates of employment, the rate of price increase is slightly higher. Thus the consumer price index increases at a 6.7% annual rate during the forecast period compared to a 6.0% increase in the baseline forecast. Similarly, the implicit GNP deflator rises at 6.5% instead of 5.8%, and the wholesale price index rises at 5.8% instead of 5.0%. The model has been adjusted so that real GNP rises at an average rate of 4.1% compared to 3.9% in the cyclical baseline case. Other variables are not significantly affected; the personal savings rate remains around 7½% and housing starts average just under 2 million units per year, although new passenger car sales rise about 1% a year faster.

TABLE 8

TEN YEAR FORECAST PREPARED BY CHASE ECONOMETRICS, INC. ON BLS BASE

VARIABLE NAME	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	ANNUALIZED COMPOUND GROWTH RATES, YEARS= 74-79	79-83	74-83
TABLE 1.1 -- GROSS NATIONAL PRODUCT IN CURRENT DOLLARS														
GROSS NATIONAL PRODUCT	1294.9	1405.1	1557.9	1738.9	1931.2	2149.6	2354.0	2555.8	2762.7	3008.9	3303.0	10.87	8.84	9.95
CONSUMPTION EXPENDITURES	805.2	879.2	975.0	1091.3	1213.8	1348.9	1478.8	1604.5	1738.4	1878.5	2048.9	10.95	8.50	9.85
AUTOMOBILES AND PARTS	57.5	52.3	62.6	71.3	78.7	84.1	88.1	91.9	96.7	102.4	109.7	11.00	5.64	8.58
OTHER DURABLE GOODS	72.8	79.9	86.9	95.4	104.5	115.1	124.8	133.6	142.1	152.0	164.7	9.33	7.18	8.36
NONDURABLE GOODS	338.0	379.7	416.2	462.4	511.3	561.7	609.9	656.5	704.6	757.9	821.1	9.98	7.72	8.94
SERVICES	336.9	367.3	409.4	462.1	519.3	588.1	655.6	722.4	791.2	866.2	953.4	12.29	9.81	11.17
GROSS PRIVATE INVESTMENT	209.4	213.2	237.0	267.8	303.0	347.5	377.4	405.2	429.3	475.4	539.0	12.10	9.32	10.84
FIXED INVESTMENT	194.0	201.2	232.0	259.0	291.5	330.1	360.7	388.9	419.3	462.5	519.0	12.39	9.52	11.10
NONRESIDENTIAL	136.8	151.9	173.0	196.1	220.3	248.4	273.3	299.5	329.2	364.3	406.8	14.47	10.45	11.55
STRUCTURES	47.0	53.4	59.6	66.2	74.6	83.6	91.3	101.2	114.9	131.0	148.3	11.33	12.89	12.01
EQUIPMENT	89.8	98.5	113.3	129.9	145.7	164.9	182.0	198.4	214.3	233.3	258.5	13.06	9.16	11.30
RESIDENTIAL STRUCTURES	57.2	49.3	59.0	62.9	71.2	81.6	87.4	89.4	90.1	98.2	112.3	12.15	6.47	9.38
NONFARM	56.7	48.5	58.3	62.1	70.3	80.7	86.4	88.3	89.0	97.0	111.0	12.23	6.47	9.62
CHANGE IN INVENTORIES	15.4	12.1	5.0	8.8	11.5	17.4	16.7	16.2	10.0	12.9	20.0	6.72	6.60	5.77
NONFARM	11.4	9.2	3.9	8.5	11.5	17.4	16.7	16.2	10.0	12.9	20.0	12.75	4.60	9.05
NET EXPORTS OF GOODS AND SERV	5.9	5.1	5.1	4.3	4.3	3.5	5.5	6.2	6.8	6.2	3.9	1.65	-7.96	-2.73
EXPORTS	100.4	141.3	162.5	178.1	191.8	210.8	231.9	253.8	277.2	302.6	330.7	10.42	9.27	9.90
IMPORTS	96.4	136.2	157.4	173.7	187.5	207.3	226.4	247.5	270.3	296.3	326.7	10.78	9.60	10.20
GOVERNMENT PURCHASES	276.4	307.8	340.8	375.5	410.2	449.7	492.8	540.0	592.0	648.8	711.1	9.87	9.60	9.74
FEDERAL	106.6	114.9	124.4	136.7	149.0	162.9	178.0	192.3	212.8	231.9	253.4	9.14	9.24	9.18
NATIONAL DEFENSE	74.4	76.6	80.3	86.7	93.8	101.9	110.5	119.8	130.9	140.9	152.9	7.59	8.46	7.97
OTHER	32.2	38.3	44.1	50.0	55.2	61.1	67.5	74.5	82.4	91.0	100.5	12.01	10.48	11.31
STATE AND LOCAL	169.8	192.8	216.4	238.7	261.2	286.8	314.8	345.7	379.6	416.8	457.7	10.30	9.80	10.07
TABLE 1.2 -- OTHER MAJOR ECONOMIC INDICATORS														
GNP IN 1958 DOLLARS	839.2	829.2	844.5	884.0	930.1	981.2	1017.9	1049.3	1078.6	1118.7	1169.4	6.19	3.53	3.89
IMPLICIT GNP DEFLATOR	154.3	169.5	184.4	196.7	207.6	219.0	231.2	243.5	256.1	268.9	282.4	6.41	5.13	5.83
CONSUMER PRICE INDEX	133.1	147.6	160.4	171.2	181.5	192.4	203.5	214.7	226.1	237.7	249.9	6.68	5.27	6.02
WHSL PRICE INDEX (INDUS COMM)	125.9	152.4	170.6	179.0	187.2	196.1	204.8	212.9	220.6	228.5	237.1	6.10	3.72	5.03
INDEX OF INDUS PROD, TOTAL	125.4	125.8	129.9	137.6	144.5	151.6	156.3	160.4	164.3	170.1	177.9	4.43	3.29	3.98
INDEX OF INDUS PROD, MFG.	125.1	125.9	129.8	137.7	144.5	151.7	156.2	160.3	164.1	170.0	177.9	4.41	3.31	3.92
INDEX OF INDUS PROD, STEEL	121.1	119.1	124.2	132.4	139.6	143.6	143.7	144.3	143.1	147.3	153.9	3.82	1.73	2.88
DISPOSABLE PERSONAL INCOME	903.7	985.0	1089.4	1211.4	1345.8	1488.4	1629.7	1772.7	1920.8	2088.4	2284.3	10.59	8.81	9.79
CORP PROFITS BEFORE TAX	122.7	142.2	137.1	158.3	181.8	209.2	227.8	247.7	267.1	294.9	331.5	9.87	9.83	9.85
CORP PROFITS AFTER TAX	72.9	86.1	78.6	90.8	103.4	121.0	133.0	145.6	158.0	175.4	197.8	9.09	10.42	9.67
MONEY SUPPLY NO TIME DEP (M1)	263.8	279.4	291.3	308.9	324.7	345.2	366.6	389.1	412.9	437.7	463.9	5.58	6.06	5.79
MONEY SUPPLY +TD -CD (M2)	549.4	595.9	639.5	685.7	731.0	792.3	855.7	922.4	992.8	1066.5	1143.0	7.51	7.51	7.50
MONEY SUPPLY +ITH TIME DEP	609.1	683.7	749.0	799.2	848.5	913.8	981.2	1051.9	1126.3	1204.0	1284.5	7.49	6.97	7.25
TREASURY BILL RATE, 91-DAY	7.02	7.60	6.58	6.93	7.00	6.91	6.96	6.94	6.95	7.05	7.33	-1.75	1.32	-.40
COMMERCIAL PAPER RATE, 4-6 MO	8.15	10.23	7.82	7.95	8.33	8.16	8.20	8.15	8.13	8.21	8.47	-4.34	.84	-2.07
AA CORPORATE RATE, NEW ISSUES	7.89	9.58	10.59	10.97	11.47	10.97	11.01	11.03	10.97	10.87	11.05	2.81	.10	1.59
INDEX OF CAPACITY UTILIZATION	91.09	87.29	85.40	85.68	85.93	86.70	86.22	85.80	85.34	85.26	85.50	-.25	-.21	-.23
NEW PASSENGER CAR SALES, SAAR	11.54	9.37	10.34	11.15	11.34	11.70	11.80	11.85	12.04	12.51	12.81	4.71	2.08	3.53
TOTAL PRIVATE HOUSING STARTS	2.05	1.60	1.90	1.88	1.93	2.03	2.00	1.91	1.82	1.88	1.98	4.54	-.31	2.35
UNEMPLOYMENT RATE	4.8	5.2	5.5	5.3	4.8	4.4	4.4	4.5	4.7	4.6	4.4	-3.33	.17	-1.79
PERSONAL SAVINGS RATE	8.2	8.1	7.9	7.4	7.3	6.9	6.8	6.9	7.1	7.5	7.8	-3.55	3.55	-.46
FEDERAL GOVT SURPLUS OR DEF	-5.6	-2.2	2.3	3.1	2.7	8.7	8.5	6.4	1.0	-2.7	-1.7	.00*	.00*	.00*

TABLE 8 (cont'd)

TEN YEAR FORECAST PREPARED BY CHASE ECONOMETRICS, INC. ON BLS BASE

VARIABLE NAME	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
TABLE 1.1A GROSS NATIONAL PRODUCT IN CURRENT DOLLARS (PERCENT CHANGE)											
GROSS NATIONAL PRODUCT	11.8	8.5	10.9	11.6	11.1	11.3	9.5	8.6	8.1	8.9	9.8
CONSUMPTION EXPENDITURES	10.5	9.2	10.9	11.9	11.2	11.1	9.6	8.5	8.1	8.3	9.1
AUTOMOBILES AND PARTS	8.3	-9.2	19.7	14.0	10.3	6.9	4.7	4.3	5.2	6.0	7.1
OTHER DURABLE GOODS	11.4	9.8	8.7	9.8	9.5	10.1	8.4	7.1	6.4	6.9	8.4
NONDURABLE GOODS	12.8	12.3	9.6	11.1	10.6	9.9	8.6	7.7	7.3	7.6	8.3
SERVICES	8.4	9.0	11.5	12.9	12.4	14.2	11.5	10.2	9.5	9.5	10.1
GROSS PRIVATE INVESTMENT	16.8	1.8	11.2	13.0	13.1	14.7	8.6	7.4	6.0	10.7	13.4
FIXED INVESTMENT	13.6	3.7	15.4	11.6	12.5	13.2	9.3	7.8	7.8	10.3	12.2
NONRESIDENTIAL	17.1	11.1	13.9	13.4	12.3	12.8	10.0	9.6	9.9	10.7	11.7
STRUCTURES	14.4	13.6	11.7	11.0	12.6	12.1	9.2	10.8	13.6	14.1	13.2
EQUIPMENT	18.6	9.8	15.0	14.6	12.1	13.2	10.4	9.0	8.0	8.9	10.8
RESIDENTIAL STRUCTURES	5.9	-15.9	19.9	6.6	13.2	14.6	7.0	2.3	.8	9.0	14.3
NONFARM	6.3	-14.5	20.1	6.6	13.3	14.7	7.1	2.3	.7	9.0	14.4
EXPORTS	38.6	40.8	15.0	9.6	7.7	9.9	10.0	9.4	9.2	9.2	9.3
IMPORTS	23.0	41.3	15.6	10.4	7.9	10.6	9.2	9.3	9.2	9.6	10.3
GOVERNMENT PURCHASES	8.1	11.4	10.7	10.2	9.2	9.6	9.6	9.6	9.6	9.6	9.6
FEDERAL	1.6	7.8	8.2	9.9	9.0	9.4	9.2	9.2	9.3	9.2	9.3
NATIONAL DEFENSE	-.5	5.0	4.8	8.0	8.2	8.6	8.5	8.4	8.5	8.4	8.5
OTHER	6.9	19.0	15.2	13.5	10.3	10.6	10.5	10.4	10.6	10.5	10.5
STATE AND LOCAL	12.6	13.6	12.2	10.3	9.4	9.8	9.8	9.8	9.8	9.8	9.8
TABLE 1.2A OTHER MAJOR ECONOMIC INDICATORS (PERCENT CHANGE)											
GNP IN 1958 DOLLARS	5.9	-1.2	1.8	4.7	5.2	5.5	3.7	3.1	2.8	3.7	4.5
IMPLICIT GNP DEFLATOR	5.6	9.8	8.8	6.6	5.6	5.5	5.6	5.3	5.2	5.0	5.0
CONSUMER PRICE INDEX	6.2	10.9	8.7	6.8	6.0	6.0	5.8	5.5	5.3	5.1	5.1
WHSL PRICE INDEX (INDUS COMM)	6.8	21.1	12.0	4.9	4.5	4.8	4.8	3.9	3.6	3.6	3.7
INDEX OF INDUS PROD, TOTAL	8.8	.3	3.2	6.0	5.0	4.9	3.1	2.7	2.8	3.5	4.6
INDEX OF INDUS PROD,MFG.	9.7	.6	3.1	6.0	4.9	5.0	3.0	2.6	2.4	3.6	4.7
INDEX OF INDUS PROD,STEEL	13.1	-1.6	4.2	6.6	5.4	2.9	.0	.8	-.8	2.9	4.5
DISPOSABLE PERSONAL INCOME	12.6	9.0	10.6	11.2	11.1	10.6	9.5	8.8	8.4	8.7	9.4
CORP PROFITS BEFORE TAX	25.7	15.9	-3.6	15.4	14.9	15.0	8.9	8.7	7.9	10.4	12.4
CORP PROFITS AFTER TAX	26.4	18.1	-8.8	15.6	13.9	17.0	10.0	9.4	8.5	11.1	12.8
MONEY SUPPLY NO TIME DEP (M1)	6.3	5.2	5.2	5.9	5.4	6.3	6.2	6.1	6.1	6.0	6.0
MONEY SUPPLY +TD -CD (M2)	8.9	7.2	8.1	7.0	7.2	8.1	7.9	7.7	7.6	7.3	7.1
MONEY SUPPLY +ITH TIME DEP	12.0	13.3	7.7	6.5	6.7	7.5	7.3	7.1	7.0	6.8	6.6
TABLE 1.2B OTHER MAJOR ECONOMIC INDICATORS (ACTUAL CHANGE)											
TREASURY BILL RATE, 91-DAY	2.95	.58	-1.02	.36	.06	-.09	.05	-.02	.01	.10	.28
COMMERCIAL PAPER RATE, 4-6 MO	3.46	2.08	-2.41	.13	.37	-.16	.03	-.05	-.02	.08	.27
AA CORPORATE RATE, NEW ISSUES	.30	1.69	1.01	.37	.50	-.59	.03	.03	-.06	-.10	.18
INDEX OF CAPACITY UTILIZATION	4.09	-3.80	-1.90	.28	.26	.77	-.49	-.42	-.46	-.07	.23
NEW PASSENGER CAR SALES, SAAR	.59	-2.17	.97	.81	.19	.37	.07	.06	.19	.27	.50
TOTAL PRIVATE HOUSING STARTS	-.31	-.45	.30	-.02	.06	.09	-.03	-.09	-.09	.06	.10
UNEMPLOYMENT RATE	-.8	.4	.3	-.3	-.4	-.4	.0	.1	.1	-.0	-.2
PERSONAL SAVINGS RATE	1.6	-.1	-.2	-.5	-.1	-.4	-.1	.2	.2	.4	.3
FEDERAL GOVT SURPLUS OR DEF	11.9	3.5	4.5	.8	-.4	6.1	-.2	-2.3	-5.4	-3.7	1.0

TABLE 9 TEN YEAR FORECAST PREPARED BY CHASE ECONOMETRICS, INC. INCLUDING POLLUTION CONTROL COSTS

VARIABLE NAME	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	ANNUALIZED COMPOUND GROWTH RATES, YEARS 74-79	79-83	74-83
TABLE 1.1 -- GROSS NATIONAL PRODUCT IN CURRENT DOLLARS														
GROSS NATIONAL PRODUCT	1294.9	1413.8	1586.8	1779.1	1962.0	2157.7	2344.5	2550.7	2775.8	3030.9	3318.2	10.65	9.07	9.93
CONSUMPTION EXPENDITURES	805.2	861.9	988.3	1112.7	1235.7	1362.0	1479.6	1602.2	1738.2	1887.4	2055.2	10.90	8.56	9.85
AUTOMOBILES AND PARTS	57.5	52.7	64.2	73.4	80.2	84.3	87.8	92.9	99.0	105.0	111.7	10.76	6.20	8.70
OTHER DURABLE GOODS	72.8	80.2	88.5	98.1	107.1	116.3	124.3	132.8	142.3	152.9	165.2	9.19	7.37	8.38
NONDURABLE GOODS	338.0	380.6	420.9	470.2	518.8	565.5	608.8	654.1	704.3	759.3	821.1	9.85	7.76	8.91
SERVICES	336.9	368.4	414.7	471.0	529.6	595.8	658.6	722.3	792.7	870.3	957.2	12.32	9.80	11.18
GROSS PRIVATE INVESTMENT	209.4	219.5	254.6	286.0	310.1	340.0	363.9	400.6	438.2	488.0	586.6	10.64	10.70	10.66
FIXED INVESTMENT	194.0	206.3	247.3	275.8	299.4	326.2	351.9	385.8	425.7	471.6	525.3	11.27	10.54	10.93
NONRESIDENTIAL	136.8	157.7	190.8	218.3	237.8	255.9	272.7	298.2	332.2	368.6	411.3	11.87	10.82	11.22
STRUCTURES	47.0	56.4	68.4	77.6	83.5	86.1	88.8	96.9	111.4	126.7	144.4	9.81	12.95	11.81
EQUIPMENT	89.8	101.4	122.4	140.7	154.2	169.8	184.0	201.3	220.8	241.9	266.9	12.65	9.75	11.34
RESIDENTIAL STRUCTURES	57.2	48.5	56.6	57.5	61.7	70.3	79.2	87.7	93.5	103.0	114.0	10.27	9.98	9.94
NONFARM	56.7	47.8	55.8	56.6	60.8	69.4	78.2	86.6	92.4	101.8	112.7	10.33	9.98	9.99
CHANGE IN INVENTORIES	15.4	13.2	7.3	10.3	10.7	13.8	12.1	14.7	12.5	16.3	21.3	-1.81	15.29	5.45
NONFARM	11.4	10.3	6.2	10.0	10.7	13.8	12.1	14.7	12.5	16.3	21.3	3.16	15.29	8.39
NET EXPORTS OF GOODS AND SERV	3.9	4.6	3.1	4.9	6.1	6.1	8.2	6.0	7.4	6.8	5.2	12.22	-10.75	1.34
EXPORTS	100.4	141.3	162.8	179.8	194.1	212.9	233.6	255.4	278.9	304.6	332.7	10.58	9.24	9.97
IMPORTS	96.4	136.7	159.8	174.8	188.0	206.8	225.4	247.4	271.6	297.8	327.5	10.52	9.79	10.19
GOVERNMENT PURCHASES	276.4	307.8	340.8	375.5	410.2	449.7	492.8	540.0	592.0	648.8	711.1	9.87	9.60	9.74
FEDERAL	106.6	114.9	124.4	136.7	149.0	162.9	178.0	194.3	212.4	231.9	253.4	9.14	9.26	9.18
NATIONAL DEFENSE	74.4	76.6	80.3	86.7	93.8	101.9	110.5	119.8	130.0	140.9	152.9	7.59	8.46	7.97
OTHER	32.2	38.3	44.1	50.0	55.2	61.1	67.5	74.5	82.4	91.0	100.5	12.01	10.48	11.31
STATE AND LOCAL	169.8	192.8	216.4	238.7	261.2	286.8	314.8	345.7	379.6	416.8	457.7	10.30	9.80	10.07
TABLE 1.2 -- OTHER MAJOR ECONOMIC INDICATORS														
GNP IN 1958 DOLLARS	839.2	834.0	857.7	893.7	928.4	966.8	997.6	1033.6	1072.4	1116.9	1166.2	3.65	3.98	3.79
IMPLICIT GNP DEFLATOR	154.3	169.5	185.0	199.0	211.3	223.1	235.0	246.7	258.8	271.3	284.5	6.75	6.89	5.92
CONSUMER PRICE INDEX	133.1	147.7	161.0	172.6	183.7	194.9	205.8	216.3	227.1	238.3	250.1	6.87	6.99	6.02
WHSL PRICE INDEX (INDUS COMM)	125.9	152.5	172.2	184.1	193.3	202.1	210.2	218.0	225.9	233.9	242.2	6.63	5.60	5.27
INDEX OF INDUS PROD, TOTAL	125.4	126.9	133.0	140.1	145.0	149.7	153.1	158.1	163.6	170.0	177.4	3.82	3.75	3.78
INDEX OF INDUS PROD, MFG.	125.1	127.2	133.5	140.5	145.0	149.4	152.5	157.5	163.1	169.6	177.1	3.69	3.81	3.74
INDEX OF INDUS PROD, STEEL	121.1	121.8	129.9	136.2	138.8	137.9	136.1	139.1	141.3	146.1	151.7	2.28	2.76	2.47
DISPOSABLE PERSONAL INCOME	903.7	988.8	1104.2	1236.0	1370.3	1503.8	1633.0	1772.3	1925.1	2095.0	2286.8	10.55	8.78	9.78
CORP PROFITS BEFORE TAX	122.7	145.3	146.8	165.3	179.1	198.0	213.8	236.6	261.4	290.1	325.1	8.03	11.06	9.38
CORP PROFITS AFTER TAX	72.9	88.0	84.4	95.0	101.8	114.2	124.7	139.0	154.5	172.5	194.0	7.22	11.69	9.18
MONEY SUPPLY NO TIME DEP (M1)	263.8	279.4	291.4	309.0	324.9	345.3	366.7	389.2	412.9	437.8	463.9	5.59	6.06	5.79
MONEY SUPPLY +TD -CD (M2)	549.4	595.7	637.2	682.9	727.9	790.0	854.6	922.2	992.5	1065.9	1142.2	7.49	7.52	7.49
MONEY SUPPLY WITH TIME DEP	609..	663.6	746.8	796.4	845.4	911.5	980.1	1051.7	1126.0	1203.4	1283.7	7.47	6.98	7.23
TREASURY BILL RATE, 91-DAY	7.0.	7.70	6.93	7.37	7.26	6.92	6.74	6.74	6.84	7.00	7.25	-2.64	1.86	-.67
COMMERCIAL PAPER RATE, 4-6 MO	8.5	10.33	8.19	8.43	8.63	8.21	7.97	7.91	7.98	8.13	8.37	-5.06	1.22	-2.31
AA CORPORATE RATE, NEW ISSUES	7.89	9.70	11.29	11.85	12.47	11.77	11.44	11.23	11.16	11.18	11.43	3.35	-.03	1.83
INDEX OF CAPACITY UTILIZATION	91.09	87.92	86.85	86.22	85.21	85.09	84.63	85.08	85.52	85.64	85.43	-.76	.29	-.29
NEW PASSENGER CAR SALES, SAAR	11.54	9.41	10.43	11.14	11.20	11.32	11.32	11.58	11.98	12.29	12.72	3.76	2.96	3.40
TOTAL PRIVATE HOUSING STARTS	2.05	1.55	1.79	1.66	1.64	1.72	1.82	1.87	1.86	1.92	1.97	3.28	1.92	2.68
UNEMPLOYMENT RATE	4.8	5.1	5.1	5.0	4.8	4.6	4.6	4.8	4.8	4.7	4.5	-1.23	-1.58	-1.39
PERSONAL SAVINGS RATE	8.2	8.2	7.9	7.5	7.3	6.9	6.8	7.0	7.1	7.3	7.6	-3.48	2.84	-.85
FEDERAL GOVT SURPLUS OR DEF	-5.6	-.2	9.1	10.6	6.3	7.2	3.7	2.4	.3	-2.4	-2.9	.00*	.00*	.00*

TEN YEAR FORECAST PREPARED BY CHASE ECONOMETRICS, INC. INCLUDING POLLUTION CONTROL COSTS

TABLE 9 (cont'd)

VARIABLE NAME	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
TABLE 1.1A GROSS NATIONAL PRODUCT IN CURRENT DOLLARS (PERCENT CHANGE)											
GROSS NATIONAL PRODUCT	11.8	9.2	12.2	12.1	10.3	10.0	8.7	8.6	8.8	9.2	9.5
CONSUMPTION EXPENDITURES	10.5	9.5	12.1	12.6	11.1	10.2	8.6	8.3	8.5	8.6	8.9
AUTOMOBILES AND PARTS	8.3	-8.4	21.9	14.3	9.2	5.1	4.2	5.7	6.6	6.1	6.4
OTHER DURABLE GOODS	11.4	10.2	10.2	10.9	9.2	8.6	8.9	8.8	7.1	7.4	8.1
NONDURABLE GOODS	12.8	12.6	10.6	11.7	10.3	9.0	7.7	7.4	7.7	7.8	8.1
SERVICES	8.4	9.3	12.6	13.6	12.4	12.5	10.5	9.7	9.7	9.8	10.0
GROSS PRIVATE INVESTMENT	16.8	4.8	16.0	12.3	8.4	9.6	7.1	10.1	9.4	11.4	12.0
FIXED INVESTMENT	13.6	6.3	19.9	11.5	8.6	8.9	7.9	9.7	10.3	10.8	11.4
NONRESIDENTIAL	17.1	15.3	20.9	14.4	8.9	7.6	6.6	9.3	11.4	11.0	11.6
STRUCTURES	14.4	19.9	21.3	13.5	7.6	3.1	3.0	9.1	15.0	13.8	14.0
EQUIPMENT	18.6	13.0	20.7	15.0	9.6	10.1	8.4	9.4	9.7	9.6	10.3
RESIDENTIAL STRUCTURES	5.9	-15.1	16.6	1.6	7.3	14.0	12.6	10.7	6.7	10.1	10.7
NONFARM	6.3	-15.7	16.7	1.5	7.3	14.1	12.7	10.8	6.7	10.2	10.7
EXPORTS	38.6	40.8	15.2	10.4	8.0	9.7	9.7	9.3	9.2	9.2	9.2
IMPORTS	23.0	41.7	16.9	9.4	7.5	10.0	9.0	9.8	9.8	9.6	10.0
GOVERNMENT PURCHASES	8.1	11.4	10.7	10.2	9.2	9.6	9.6	9.6	9.6	9.6	9.6
FEDERAL	1.6	7.8	8.2	9.9	9.0	9.4	9.2	9.2	9.3	9.2	9.3
NATIONAL DEFENSE	-.5	3.0	4.8	8.0	8.2	8.6	8.5	8.4	8.5	8.4	8.5
OTHER	6.9	19.0	15.2	13.5	10.3	10.6	10.5	10.4	10.6	10.5	10.5
STATE AND LOCAL	12.6	13.6	12.2	10.3	9.4	9.8	9.8	9.8	9.8	9.8	9.8
TABLE 1.2A OTHER MAJOR ECONOMIC INDICATORS (PERCENT CHANGE)											
GNP IN 1958 DOLLARS	5.9	-.6	2.8	4.2	3.9	4.1	3.2	3.6	3.7	4.2	4.4
IMPLICIT GNP DEFLATOR	5.6	9.8	9.1	7.6	6.2	5.6	5.3	5.0	4.9	4.8	4.9
CONSUMER PRICE INDEX	6.2	11.0	9.0	7.2	6.4	6.1	5.6	5.1	5.0	4.9	5.0
WHSL PRICE INDEX (INDUS COMM)	6.8	21.2	12.9	6.9	5.0	4.5	4.0	3.7	3.6	3.5	3.6
INDEX OF INDUS PROD, TOTAL	8.8	1.2	4.7	5.4	3.5	3.2	2.3	3.3	3.4	3.9	4.3
INDEX OF INDUS PROD,MFG.	9.7	1.7	4.9	5.2	3.2	3.0	2.1	3.3	3.5	4.0	4.4
INDEX OF INDUS PROD,STEEL	13.1	.6	6.6	4.9	1.9	-.7	-1.3	2.2	1.6	3.4	3.8
DISPOSABLE PERSONAL INCOME	12.6	9.4	11.7	11.9	10.9	9.7	8.6	8.5	8.6	8.8	9.2
CORP PROFITS BEFORE TAX	23.7	18.4	1.1	12.6	8.4	10.5	8.0	10.7	10.5	11.0	12.0
CORP PROFITS AFTER TAX	26.4	20.6	-4.1	12.5	7.1	12.2	9.1	11.5	11.2	11.7	12.4
MONEY SUPPLY NO TIME DEP (M1)	6.3	5.2	5.2	5.9	5.4	6.3	6.2	6.1	6.1	6.0	6.0
MONEY SUPPLY +TD -CD (M2)	8.9	7.1	7.7	7.0	7.3	8.3	8.1	7.8	7.5	7.3	7.1
MONEY SUPPLY WITH TIME DEP	12.0	13.2	7.3	6.5	6.7	7.6	7.5	7.2	7.0	6.8	6.6
TABLE 1.2B OTHER MAJOR ECONOMIC INDICATORS (ACTUAL CHANGE)											
TREASURY BILL RATE, 91-DAY	2.95	.68	-.77	.44	-.11	-.34	-.18	.00	.10	.16	.24
COMMERCIAL PAPER RATE, 4-6 MO	3.46	2.18	-2.14	.23	.20	-.42	-.24	-.06	.06	.15	.24
AA CORPORATE RATE, NEW ISSUES	.30	1.81	1.59	.56	.61	-.70	-.33	-.21	-.07	.02	.24
INDEX OF CAPACITY UTILIZATION	4.09	-3.17	-1.08	-.65	-1.00	-.12	-.46	.45	.44	.12	-.01
NEW PASSENGER CAR SALES, SAAR	.59	-2.13	1.01	.72	.06	.11	.00	.26	.40	.32	.42
TOTAL PRIVATE HOUSING STARTS	-.31	-.49	.23	-.12	-.02	.08	.11	.05	-.01	.06	.05
UNEMPLOYMENT RATE	-.8	.3	.0	-.2	-.2	-.1	.2	.0	-.0	-.1	-.2
PERSONAL SAVINGS RATE	1.6	-.0	-.3	-.5	-.1	-.4	-.1	.2	.1	.2	.2
FEDERAL GOVT SURPLUS OR DEF	11.9	5.5	9.3	1.5	-4.2	.9	-3.5	-1.3	-2.1	-2.7	-.4

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A somewhat larger Federal government surplus is recorded as a result of higher real income and higher prices, although we also assume that government purchases grow at a 1% faster rate, reflecting the faster pace of both real economic activity and inflation. Summary tables from the full employment run are incorporated in this report as Table 9.

B. ALTERNATIVE SIMULATIONS -- GENERAL DISCUSSION

In this study we have calculated twelve alternative simulations. Since these represent a fairly wide diversity of alternative conditions, it may be useful to discuss the general classification of runs which were tried before examining each one individually.

1) Three different levels of pollution control expenditures were analyzed. The first level represents 100% of the figures given us by CEQ/EPA, while the second level represents 125% of the baseline expenditures. The third level assumes that capital investment would be 20% less than estimated, but that operating and maintenance (O&M) costs would be 15% higher. Since O&M costs are approximately 2/3 of total annualized costs, the latter would be 110% of the baseline expenditures. We thus refer to these runs as 0.8/1.1. A discussion with the EPA indicated that they believe these limits established the reasonable maximum levels of pollution control expenditures.

2) Two economic scenarios were used -- the cyclical baseline forecast incorporated in the Chase Econometrics ten-year macro forecast and the full employment run, based on BLS statistics, supplied by the CEQ/EPA. Both of these scenarios were discussed in the previous section.

3) Two different patterns of timing were used. In the first case the numbers were simply taken as originally supplied by the CEQ/EPA. In the second case,

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the expenditures were stretched out for all major industries, resulting in less expenditures in the first five years and more expenditures in the last five years. This alternative pattern was also supplied by CEQ/EPA. The simulations which were calculated are summarized in Table 10.

C. PRINCIPAL SIMULATION RESULTS

In this section we consider the incremental differences which occurred between the baseline scenarios and the perturbed simulations for the 100% level of expenditure case. In the first case, designated as Run 1 in Table 10 and elsewhere throughout this report, we have used the normal timing pattern and the cyclical baseline scenario. We consider this to be the most likely run of all twelve cases. The macroeconomic summary results for this case are given in Table 11 and the industry results in Table 12.

The economic effects of pollution control expenditures are found to be rather modest. By 1982 the implicit GNP deflator is only 5 basis points or 0.9% above the baseline case. The increment for the wholesale price index is only 2.4% and 0.2% for the consumer price index. The biggest incremental change in prices occurs in 1976, when the GNP deflator rises 0.9% more than would have otherwise been the case. In 1977 the incremental increase in the GNP deflator is 0.6%, and it is substantially below that amount in all other years. The wholesale price index rises an additional 1.8% in 1976 because of pollution control expenditures, which is the largest annual increase for any of the macroeconomic price indicators.

The fact that a price increase does occur occasions no surprise, since it is clear that additional expenditures that do not increase output per unit

TABLE 10

Simulations Calculated for CEQ/EPA Study

Run B1 Cyclical Baseline Run

	level of expenditure	pattern of timing	economic scenario
1	1.00	normal	cyclical
2	1.25	normal	↓
3	0.8/1.1	normal	↓
4	1.00	stretched	↓
5	1.25	stretched	↓
6	0.8/1.1	stretched	↓

Run B2 Full Employment Baseline Run

7	1.00	normal	full employment
8	1.25	normal	↓
9	0.8/1.1	normal	↓
10	1.00	stretched	↓
11	1.25	stretched	↓
12	0.8/1.1	stretched	↓

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of labor or capital will result in higher prices. However, there has been a considerable amount of disagreement about whether pollution control expenditures on balance increase or diminish the rate of real growth and employment. Some economists have argued that the additional expenditures associated with pollution control investment will result in a higher growth rate and hence a higher level of employment. In addition, since pollution control makes each unit of productive capital more expensive, it has also been argued that these new expenditures will result in a slower rate of substitution of capital for labor, hence resulting in higher employment for that reason also. While we do not deny the existence of either of these effects, a careful analysis of the simulation results reveals that they are overshadowed by the negative effect of higher inflation on real growth. This latter effect works through several different channels. First, a higher rate of inflation leads to a tighter monetary situation, which in turn results in more stringent credit conditions and declines in fixed business investment, residential construction and certain sectors of consumption. Second, a higher rate of inflation reduces our net foreign balance, at least in real terms. Third, a higher rate of inflation leads to a lower growth in constant dollar government expenditures for any given level of current dollar expenditures. Fourth, a higher rate of inflation leads to a higher personal savings rate -- partially because of a shift in consumption patterns, partially because of the perceived need of individuals to save more because their savings are worth less, and partially because of higher interest rates. In addition, the increase in expenditures for pollution control investment comes partially at the expense of lower expenditures for other plant and equipment purchases in the private sector. This phenomenon was discussed in Section I of the report where we noted that the elasticity of substitution between these two types of investment is approximately 0.4.

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As a result, we have a somewhat variegated picture of incremental pattern real growth over the forecast period. During the early years -- 1974 through 1976 -- real GNP is higher than the baseline solution and hence unemployment is lower. However, in 1977 and succeeding years the picture is reversed. First, less new investment is being added in 1977 and subsequent years. Second, the additional price increases that are occurring set in motion the forces discussed above that lead to a slower rate of real growth. Thus as a result real GNP is lower and unemployment is higher in the perturbed solution in the years 1977 through 1982.

The pattern of negative increments in real growth is not constant over this six-year period. In particular, the greatest difference is reached in 1979, when real GNP is $31 billion, or 2.0% below the baseline solution. After this occurs, countervailing forces come into place. The lower rate of growth leads to a higher rate of unemployment, which in turn leads to smaller increases in wage rates, unit labor costs and prices. In addition, a decline in capacity utilization reduces the amount of markups in several industries. Thus for the 1980-82 period the shortfall in real GNP averages only 0.2%.

Turning to the major components of investment, we find that constant dollar purchases of producers durable goods are up $6.7 billion or 7.0% in 1975, but this difference declines to -3.4% in 1979 before returning almost to zero. Nonresidential construction increases 13% in 1975 and 5% in 1977, but is 8% lower in 1979 and 1980. Housing starts are hard hit and decline by 110,000 units in 1975, 220,000 units in 1976, and 290,000 units in 1977 where they are some 15% below the baseline case. After that, the difference narrows and they are actually 2% above the baseline solution by 1982.

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It could be argued that the very substantial decline in housing is not indicative of what would actually happen in the economy, since the government could take steps to aid the housing market. In order to test this possibility, we calculated additional simulation exercises in which we returned housing to its baseline level, in order to determine whether the effect on real growth and prices would be substantially different. However, we found that this was not the case. Returning housing to its baseline level, presumably through action by the Federal government or its agencies, simply resulted in reducing the amount of funds available to the remaining borrowing sectors, particularly fixed business investment, and hence had relatively little effect on the overall macroeconomic picture.

The industry results are summarized in Table 12. In order to reduce this mass of information to manageable results, we have calculated the percentage change in price output and employment only for the two key years -- 1978 and 1982. We have listed these changes for all of the 40 industries that were used in the I/O bridge table. These industries taken together comprise the entire private sector of the economy. While not all these industries are affected directly by pollution control expenditures, it is of interest to include them in order to assess the secondary effects.

The industries that have the greatest price effects are, as would be expected, utilities, automobiles, iron and steel, and nonferrous metals, since these are exactly the same industries that have the highest ratio of pollution control expenditures to output. No other industry has an incremental increase in price as much as 2% in either 1978 or 1982.

TABLE 11

	1974	1975	1976	1977	1978	1979	1980	1981	1982
Gross National Product, Current Dollars									
Baseline projection	1405.1	1557.9	1738.9	1931.2	2149.6	2354.0	2555.8	2762.7	3008.9
With pollution control costs	1413.8	1586.8	1779.1	1962.0	2157.7	2344.5	2550.7	2775.8	3030.9
% Difference	.62	1.86	2.31	1.59	.38	-.40	-.20	.47	.73
Gross National Product, 1973 Dollars									
Baseline projection	1279.5	1303.1	1364.0	1435.2	1514.0	1570.6	1619.1	1664.3	1726.2
With pollution control costs	1286.9	1323.4	1379.0	1432.5	1491.8	1539.3	1594.9	1654.7	1723.4
% Difference	.58	1.56	1.10	-.19	-1.47	-1.99	-1.49	-.58	-.16
Implicit GNP Deflator, 1973 = 100									
Baseline projection	109.8	119.5	127.5	134.5	141.9	149.8	157.8	166.0	174.3
With pollution control costs	109.8	119.9	129.0	136.9	144.6	152.3	159.9	167.7	175.8
% Difference	.00	.33	1.18	1.78	1.90	1.67	1.33	1.02	.86
Consumer Price Index, 1973 = 100									
Baseline projection	110.9	120.5	128.6	136.4	144.6	152.9	161.3	169.9	178.6
With pollution control costs	111.0	121.0	129.4	138.0	146.4	154.6	162.5	170.6	179.0
% Difference	.09	.41	.62	1.17	1.24	1.11	.74	.41	.22
Wholesale Price Index, 1973 = 100									
Baseline projection	121.0	135.5	142.2	148.7	155.8	162.7	169.1	175.2	181.5
With pollution control costs	121.1	136.8	146.2	153.5	160.5	167.0	173.2	179.4	185.8
% Difference	.08	.96	2.81	3.23	3.02	2.64	2.42	2.40	2.37
Unemployment Rate, Percent									
Baseline projection	5.2	5.5	5.3	4.8	4.4	4.4	4.5	4.7	4.6
With pollution control costs	5.1	5.1	5.0	4.8	4.6	4.8	4.8	4.8	4.7
% Difference	-1.92	-7.27	-5.66	.00	4.55	9.09	6.67	2.13	2.17
Fixed Investment in Producers Durable Equipment, 1973 Dollars									
Baseline projection	91.4	95.7	102.8	109.3	116.7	121.8	126.4	130.4	135.9
With pollution control costs	93.8	102.4	107.4	110.2	114.4	117.7	123.0	129.0	135.4
% Difference	2.63	7.00	4.47	.82	-1.97	-3.37	-2.69	-1.07	-.37

TABLE 11 (cont'd)

	1974	1975	1976	1977	1978	1979	1980	1981	1982
Fixed Investment in Nonresidential Structures, 1973 Dollars									
Baseline projection	50.0	51.1	52.7	55.5	57.5	58.3	60.1	63.8	68.1
With pollution control costs	52.6	57.7	58.8	58.3	55.9	53.8	55.1	59.6	63.5
% Difference	5.2	12.92	11.57	5.05	-2.78	-7.72	-8.32	-6.58	-6.75
Housing Starts, Millions of Units									
Baseline projection	1.60	1.90	1.88	1.93	2.03	2.00	1.91	1.82	1.88
With pollution control costs	1.55	1.79	1.66	1.64	1.72	1.82	1.87	1.86	1.92
% Difference	-3.13	-5.79	-11.70	-15.03	-15.27	-9.00	-2.09	2.20	2.13
Percentage Growth Rate of GNP, 1973 Dollars									
Baseline projection	-1.2	1.8	4.7	5.2	5.5	3.7	3.1	2.8	3.7
With pollution control costs	-.6	2.8	4.2	3.9	4.1	3.2	3.6	3.7	4.2
Difference	.6	1.0	-.5	-1.3	-1.4	-.5	.5	.9	.5
Percentage Growth Rate of CPI									
Baseline projection	10.9	8.7	6.8	6.0	6.0	5.8	5.5	5.3	5.1
With pollution control costs	11.0	9.0	7.2	6.4	6.1	5.6	5.1	5.0	4.9
Difference	.1	.3	.4	.4	.1	-.2	-.4	-.3	-.2
Trade Balance, 1973 Dollars									
Baseline projection	8.9	6.0	6.0	7.4	9.1	11.1	12.5	13.8	14.7
With pollution control costs	8.7	5.0	5.6	7.3	8.8	10.5	11.7	13.0	14.0
% Difference	-2.25	-16.67	-6.67	-1.35	-3.30	-5.41	-6.40	-5.80	-4.76
Consumption of Autos and Parts, 1973 Dollars									
Baseline projection	49.3	55.0	59.4	61.8	62.3	61.7	61.3	61.6	62.5
With pollution control costs	49.4	55.3	58.8	60.4	59.7	59.2	59.7	61.0	62.0
% Difference	.20	.55	-1.03	-2.27	-4.17	-4.05	-2.61	-.97	-.80
Consumption of Other Durables, 1973 Dollars									
Baseline projection	75.1	75.9	79.1	82.4	86.3	89.5	91.9	94.4	97.4
With pollution control costs	75.2	76.9	80.3	83.2	86.2	88.4	91.0	94.2	97.6
% Difference	.13	1.32	1.52	.97	-.12	-1.23	-.98	-.21	.21

TABLE 11 (cont'd)

	1974	1975	1976	1977	1978	1979	1980	1981	1982
Consumption of Nondurables, 1973 Dollars									
Baseline projection	333.7	337.3	354.2	370.7	385.7	397.8	408.7	419.5	432.0
With pollution control costs	334.4	340.1	357.7	372.7	384.8	394.8	405.9	418.4	432.1
% Difference	.21	.83	.99	.54	-.23	-.75	-.69	-.26	.02
Consumption of Services, 1973 Dollars									
Baseline projection	336.5	340.5	352.7	370.4	393.2	411.4	425.3	437.3	450.5
With pollution control costs	337.3	343.8	357.0	373.4	393.0	407.9	421.1	436.0	452.2
% Difference	.24	.97	1.22	.81	-.05	-.85	-.99	-.30	.38
Disposable Personal Income, Current Dollars									
Baseline projection	985.0	1089.4	1211.4	1345.8	1488.4	1629.7	1772.7	1920.8	2088.4
With pollution control costs	988.8	1104.2	1236.0	1370.3	1503.8	1633.0	1772.3	1925.1	2095.0
% Difference	.39	1.36	2.03	1.82	1.03	.20	-.02	.22	.32
orporate Profits Before Taxes, Current Dollars									
Baseline projection	142.2	137.1	158.3	181.8	209.2	227.8	247.7	267.1	294.9
With pollution control costs	145.3	146.8	165.3	179.1	198.0	213.8	236.6	261.4	290.1
% Difference	2.18	7.08	4.42	1.49	-5.35	-6.15	-4.48	-2.13	-1.63
Corporate Profits After Taxes, Current Dollars									
Baseline projection	86.1	78.6	90.8	103.4	121.0	133.0	145.6	158.0	175.4
With pollution control costs	88.0	84.4	95.0	101.8	114.2	124.7	139.0	154.5	172.5
% Difference	2.21	7.38	4.63	-1.55	-5.62	-6.24	-4.53	-2.22	-1.65
Aa Corporate Bond Rate for New Issues									
Baseline projection	9.58	10.59	10.97	11.47	10.97	11.01	11.03	10.97	10.87
With pollution control costs	9.70	11.29	11.85	12.47	11.77	11.44	11.23	11.16	11.18
% Difference	1.25	6.61	8.02	8.72	7.29	3.91	1.81	1.73	2.85
Index of Industrial Production, 1973 = 100									
Baseline projection	100.3	103.6	109.7	115.2	120.9	124.6	127.9	131.0	135.6
With pollution control costs	101.2	106.1	111.7	115.6	119.4	122.1	126.1	130.5	135.6
% Difference	.90	2.41	1.82	.35	-1.24	-2.01	-1.41	-.38	.00

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Turning to the output column, we note immediately that the industries with the largest price increases are not at all the same as the ones with the largest declines in output. One of the largest declines in output occurs in the construction industry of 5.1%, an industry that has no primary pollution control costs. This occurs because the increase in plant and equipment spending results in a decline in residential construction purchases. The decline in lumber output of 8.7% is also a direct reflection of the decline in housing. After these two industries, automobiles are the next hardest hit, with a decline of 4.2%. This is not unexpected since the price elasticity of automobiles is still substantial and the rise in prices by 1978 is an additional 6.4%. However, the price elasticity for utilities is extremely small, so output is reduced by only 1½% in spite of a 10% increase in prices. Even this small decline in output is not due exclusively to higher prices; it also reflects the generally lower level of industrial production. The only other industries that have a decline in output of 2% or more in 1978 include stone, clay and glass, iron and steel, nonferrous metals, electrical machinery, other transportation equipment and instruments. In the case of the first three of these industries, the decline is due primarily to the lower level of construction. Electrical machines might be thought to increase because of higher plant and equipment spending; however, a large portion of this industry consists of household appliances which are tied very closely to housing starts. The decline in other transportation equipment and instruments simply reflects a high elasticity with respect to overall industrial production and economic activity.

When we turn to 1982 the results change only slightly. As indicated in the previous section, most of the price increases have already occurred by 1978 and hence there is very little further incremental price increase

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TABLE 12: Cyclical Scenario, Normal Timing, 100% Expenditures

Industry	-- By 1978 -- Prices	Output	Employment	-- By 1982 -- Prices	Output	Employment
Agriculture	.22	- 1.61	- .06	.25	- .66	.23
Mining	.33	- 1.72	- .85	.39	- .96	- .49
Construction	.16	- 5.06	.44	.18	- 3.06	.17
Food	.90	- .68	.34	.97	- .26	.18
Tobacco	.12	- .39	.0	.14	- .37	.0
Textiles	1.12	- 1.16	- .42	1.10	- .34	- .11
Apparel	.62	- .64	.12	.62	- .26	.11
Lumber	1.42	- 8.67	- 3.91	1.35	- 3.21	- 1.88
Furniture	.65	- 1.34	- 1.08	.71	- .29	- .18
Paper	1.40	- 1.55	- .91	1.43	- .95	- .62
Printing	.41	- 1.58	- .90	.43	- 1.13	- .62
Chemicals	1.06	- 1.65	- .91	1.09	- .99	- .54
Petroleum	.64	- 1.00	.0	.94	- .65	.0
Rubber	1.01	- 1.75	- .94	1.01	- 1.12	- .64
Leather	1.11	- .32	- .38	1.10	- .09	- .19
Stone, Clay & Glass	.87	- 2.07	- 1.03	1.12	- 1.13	- .84
Iron & Steel	2.08	- 2.16	- .97	2.96	- 1.23	- .66
Nonferrous Metals	3.34	- 2.38	- .99	3.60	- 1.34	- .49
Fabricated Metals	.93	- 1.30	- .82	1.11	- 1.10	- .80
Nonelectrical Machinery	.59	- 1.61	- .98	.71	- .82	- .51
Electrical Machinery	.52	- 2.26	- 1.69	.60	- 1.06	- .90
Autos	6.40	- 4.18	- 2.36	7.66	- 3.56	- 2.39
Other Trans. Equipment	.57	- 2.00	- .92	.67	- .91	- .46
Instruments	.39	- 2.03	- .78	.44	- 1.26	- .75
Misc. Manufacturing	.56	- .90	.0	.62	- .17	.23
Transportation Services	.12	- 1.07	.20	.15	- .14	.31
Communications	.17	- 1.32	- .62	.20	- .76	- .44
Utilities	10.23	- 1.53	- .41	12.25	- 1.24	- .55
Trade	.18	- .89	- .02	.21	- .36	.04
Fin. Insur. & R.E.	.09	- 1.25	- .12	.11	- .23	- .03
Services	.32	- .67		.36	- .21	

by 1982. Output declines by a smaller amount because of the general recovery of the economy relative to the baseline forecast and the decline in output is similarly smaller. It might be noted that the elasticity of employment to output in 1978 in the manufacturing sector is approximately one-half, while by 1982 it has increased to about two-thirds due to the longer adjustment period.

We next consider the 100% run with normal timing patterns superimposed on the full employment baseline. As would be expected, the price increases are slightly larger, but the differences are modest. For example, by 1982 we find that the wholesale price index is 3.8% above the full employment baseline solution; in the cyclical case the increment is only 2.4%. For the implicit GNP deflator the difference is 1.6%, compared to 0.9%, and the figures for the CPI are 0.5% and 0.2% respectively. The declines in real GNP are also similar in nature although the timing pattern is somewhat different. The increase in producers durable equipment and nonresidential construction and the decline in housing starts all follow the same pattern.

The incremental values in the cyclical and full employment cases are similar primarily because there is relatively little difference between the two economic scenarios. In particular, the cyclical scenario assumes that the unemployment rate averages approximately 4.5% whereas in the full employment scenario this rate moves from 4½% to 3.9% in 1980 and remains at that level. It is clear that somewhat greater differences would have been observed if we had run a true recession scenario with the unemployment rate as high as 10%. However, the alternative runs at full employment do indicate that the rise in prices, while somewhat greater, is not of major importance, although the difference is more significant for the WPI than for the CPI or GNP deflator.

We now consider the simulations in which the timing patterns have been stretched out but expenditures remain at the 100% level; these are Runs 4 and 10 as listed in Table 16. Run 4, which is calculated relative to the cyclical baseline scenario, is discussed first. As expected, phasing in the expenditures more evenly until 1982 does reduce the overall rate of price increase. The WPI is 1.6% higher in 1982, relative to 2.4% in Run 1, which incorporates normal timing; the implicit GNP deflator is only 0.7% higher, compared to 0.9%, and the CPI is 0.2% higher in both cases. The maximum decrement in GNP, which also occurs in 1978, is 1.1% instead of 2.0% in Run 1, and the unemployment rate is 0.2% higher instead of 0.4%. Housing starts decline a maximum of 190,000 instead of 310,000, and producers durable equipment purchases are $1.8 billion lower instead of $4.1 billion. The industry results are also similar; the price increases are smaller and the declines in output and employment are less severe.

We next consider the results in Run 10, which incorporates the assumptions of the stretched timing pattern with 100% expenditures and the full employment baseline scenario. The price increases are above Run 1, cyclical employment and normal timing, but below Run 7, full employment and normal timing. Incremental price increases by 1978 are 3.4% for the WPI, 1.5% for the implicit GNP deflator, and only 0.8% for the CPI. By 1982 these incremental increases have changed to 2.7%, 0.6%, and 0.1% respectively. Real GNP declines and unemployment increases only modestly.

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D. FURTHER ALTERNATIVE SIMULATIONS

We now consider the effects of alternative levels of pollution control expenditures under our varying assumptions about the underlying economic scenario and the pattern of timing. As mentioned earlier, we have utilized atlernative levels of expenditures of 125% of the baseline case and a combination of 80% of investment expenditures and 110% of annual costs. We examine these runs in particular to determine whether there are any significant nonlinearities in different expenditure levels and hence whether these results can be extrapolated for different alternative assumptions about pollution control spending.

By 1982 the wholesale price index has risen 5.5 points above the baseline case for the 125% expenditure level, compared with 4.3 basis points in the standard run, a differential of 28%. The additional increase in the implicit GNP deflator is only 16%, while the difference in the consumer price index is only 8%, thereby giving rise to what appears to be the paradoxical result that the increase in prices is smaller than the additional increase in expenditures. However, the results are in fact nonlinear and are closely related to the nonlinear and dynamic effects of the macro model. For example, in 1975 the incremental change in the wholesale price index in Run 2 is 38% above Run 1, and in 1976 the difference is 31%. These larger than proportional price increases lead to a sharper than proportional decline in real output. For example, the decline in GNP in 1977 for Run 1 is only $3 billion whereas in Run 2 it is $8 billion. For 1978 the GNP decline in Run 1 is $22 billion; in Run 2 it is $36 billion. Thus the higher than proportional price increases lead, as might well be expected, to higher than

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proportional declines in real production and increases in unemployment; thus increases in wage rates in future years are lower than the baseline solution, hence eventually leading to some mitigating factors affecting prices.

Considering the comparison for the investment sector, an increase in plant and equipment spending of 125% of the baseline case would have an extremely severe impact on the housing sector if offsetting policies were not implemented. Substantial increases in interest rates and tightening of credit conditions lead to a decline in housing starts from 1.93 million in the baseline case to 1.13 million under the assumptions incorporated in Run 2, for a decline of over 40%. Thus while the pollution controls do not have major effects on the rate of inflation, they do affect money markets significantly.

The industry results follow the same general pattern which would be expected from the results in Table 1 and the differences in the macroeconomic solution. The decline in construction expenditures, which is more than proportionately severe in Run 2, is reflected in the decline in the construction, lumber, stone, clay and glass, primary metals, and electrical machinery (household durables) industries. The relatively larger declines in output and employment in 1978 reflect the fact that the incremental decline in GNP for that year is some 67% greater than in Run 1. It should be noted that most of these large declines have disappeared by 1982 when GNP is only $4.4 billion or 0.4% below the baseline solution.

Turning to Run 3, we find that in 1975 and 1976 a combination of the decline of 20% in investment and an increase of 15% in maintenance costs

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reduces prices about 27%, thus again indicating the nonlinearities involved in changes in expenditures. Because prices rise less, the maximum decrement in real GNP which occurs in 1978 is only $14 billion, or 62% of Run 1. By 1982 the change in consumer prices is only 11% less, but for the GNP deflator it is 22%, and for the wholesale price index 32% less. The housing market declines by only two-thirds as much and the other disturbances to the baseline growth pattern are similarly restrained. The industry results follow the expected pattern with no significant exceptions.

We now consider Runs 5 and 6, which represent the 125% and 80/110% runs for the Chase Econometrics economic scenario and the stretched timing pattern. These runs should be compared most closely with Run 4, which involves the same underlying assumptions except that expenditures there are 100% of the baseline figures. The price increases in Runs 4, 5, and 6 are substantially smaller than their counterparts in Runs 1, 2, and 3 because of the stretched nature of the timing of pollution control expenditures; this point has already been discussed in subsection C. Very briefly, we find that at the end of the sample period the wholesale price index is some 41% higher in Run 5 and some 40% lower in Run 6 than in Run 4. These runs actually give a better indication of the nonlinearities inherent in the differential levels of expenditure because the increases themselves are much more modest on an annual basis and hence the decline in GNP is very modest. The decline in GNP in 1978 in Run 4 is only $5½ billion or approximately ½%. The decrement is $9 billion in the 125% case but is only $3 billion in the 80/110% case. Furthermore, GNP in constant dollars is above the baseline solution for all three of these runs by 1982. Hence the price differentials indicated in this set of runs is closer to a pure price effect than is the case in Runs 1-3, which depends heavily on the interaction between output, wages and unit labor costs.

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The pattern for the industry results continues to conform to previous runs. The price increases are smaller than Runs 1-3 but are still very significant for utilities, autos, and primary metals. The output and employment changes are still largest for construction, lumber, autos, stone, clay and glass, and primary metals.

We next consider the full employment runs. Runs 7 through 12 are identical to Runs 1 through 6 except that the underlying economic scenario is the full employment baseline with key parameters provided by EPA. The net effect of these runs is that the increases in price are slightly larger than in the cyclical baseline since the economy is closer to full employment and hence prices increase more rapidly per unit of change in output. It should be stressed that the price inputs for Runs 7 through 12 are identical with their counterparts for Runs 1 through 6. Thus all differences in the macro and industry forecast represent the differential reactions due to the interaction and dynamic features of the models themselves. The differences are not large but they are significant in some cases. Since we have already discussed Runs 7 and 10 in the previous section, our remarks will be confined to Runs 8 and 9 and Runs 11 and 12.

Runs 8 and 9 represent the normal timing pattern under the full employment scenario with pollution control expenses at 125% and 80/110% respectively. These runs can be compared both to the full employment Run 7 and to counterpart cyclical Runs 2 and 3. In order to avoid a hopeless maze of comparisons, we will compare them only with Run 7.

The incremental increase in wholesale prices at the end of the forecast period for Run 8 is 21% greater than Run 7 although it is 29% greater in 1976. Run 8 contains the biggest single annual incremental price increase, namely

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the increase in wholesale prices of an additional 2.2% in 1976 relative to the full employment baseline solution. However, this change is an exception; higher prices once again lead to lower output and hence mitigation of further price increases. The implicit GNP deflator is 21% higher and the consumer price index is also 21% by the end of the forecast period. Thus in this particular case we have the unusual phenomenon of the implicit GNP deflator, CPI and the WPI all ending up 21% above the incremental values of Run 7. This conformity does not appear in any other year and it is a coincidence that it occurs in 1982. In Run 9 we find that the increase in prices by 1982 is 9% less for the GNP deflator, 4% for the consumer price index and 8% less for the wholesale price index than for Run 7. The reason the differences are so small is that there is virtually no decline in GNP and hence no offsetting differential in wages and unit labor costs.

The last set of runs that we consider are Runs 11 and 12, which employ the full employment economic scenario, the stretched pattern of timing, and the 125% and 80/110% levels of expenditures. In Run 11 prices average about 15% above the incremental values obtained in Run 10 and in Run 12 average about 10% less. Since these differences are so modest we do not comment on them at great length.